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EDITOR'S PREFACE

This paper represents a piece of coöperation between the Psychological Laboratory of Ohio State University and the Columbus State Hospital. While the author and the editor are responsible for the plan of the experiments, the execution of the work, and the conclusions reached, the superintendent and staff of the hospital have a share in whatever of merit there is in the work, on account of the cordial spirit of helpfulness which they showed while the work was in progress. Without their aid such a study from this laboratory would not have been possible.

AN EXPERIMENTAL STUDY OF DEMENTIA PRÆCOX

L. C. GATEWOOD, M.A.

INTRODUCTION

In beginning a careful study of any disease the question of first importance is, "What is this pathological condition under consideration? What is its scope and what its limitations?" Though there are many definitions of dementia præcox which may serve to partially answer this question, there is none which is clear, concise and at the same time complete. Investigation has shown that there are no hard and fast lines which may be laid down as definitely marking the limitations of this remarkable disease. Though there are recognized various disturbances of the fundamental psychic processes with their characteristic symptoms, these are not such as lend themselves readily to the formation of a satisfactory definition. It is the purpose of this paper, not to formulate a new definition, but to describe and discuss an experimental study of the disturbances of some of the fundamental psychic processes as found in dementia præcox patients at the Columbus State Hospital for the Insane[1], and to compare these processes in the abnormal with the same processes in normal persons.

The first work of this sort was done by Kraepelin and we are indebted to him for the concept, 'Dementia Præcox.' In the formation of this class he seems to have combined three groups of cases each of which was already described and named.[2]

[1] I wish to acknowledge my indebtedness to the Medical Staff of the Columbus State Hospital for the Insane and particularly to Dr. Stockton, the Medical Superintendent, for the many privileges allowed me, and to Drs. Gaver, Williams and Brundage for their valuable assistance in the selection of cases and the compiling of case histories.

[2] Defendorf, "Clinical Psychiatry" (Dementia Præcox), p. 219.

Later investigation has confirmed the keen insight which placed them together and has minimized the importance of the sub-grouping. It is impossible to make clear differential diagnoses between sub-groups in many cases and this classification, though in some respects adapted to hospital work, is quite inadequate from a psychological standpoint. While some cases may fit perfectly into one of these types, the majority do not and it is rarely possible to say definitely that Case X is one of pure hebephrenia, that Y is catatonia or that Z is one of the paranoid forms. This is well illustrated in some of the cases herein reported. Thus the original diagnosis in Case L. D. J. was hebephrenia but within a few weeks negativism appeared and soon the patient showed stereotypy and, in fact, nearly all of the symptoms of catatonia. Some months later the stereotypy had disappeared and in its place the patient exhibited marked unstable delusions of a paranoid character. Another patient showed the usual hebephrenic symptoms and with them well-marked paranoid delusions, while a third so-called hebephrenic had catatonic states with cerea flexibilitas, paranoid delusions and also some of the characteristic symptoms of paresis.

As a result of the difficulties of this classification dementia præcox has come to be studied, not as a group containing three distinct diseases, but as an entity, a disease complex resulting from the combination of a number of comparatively simple disorders, varying slightly in different cases, but each of which is well defined and has its own part in the final result, the progressive mental deterioration which Kraepelin has named as the most prominent symptom of dementia præcox. Working on this theory I have made a study of the disturbances of attention, association, perception, memory, judgment, volition, motor efficiency and emotional states and have compared the working of these processes in patients at the Columbus State Hospital with the same processes in persons supposed to be normal.

The patients were studied in the different wards and notes were kept in which unusual or significant facts were recorded together with some typical bits of conversation illustrating various phases of a patient's mental condition. The history of each patient was traced as far as possible, especially as regards

history of family tendencies, alcoholism, etc., history of onset of the disease and of any previous attacks. For the purpose of obtaining more exact data concerning the course of the disease and its effect on the various mental processes—data which would themselves show the deterioration process far more effectively than those of observation and conversation—I arranged a set of experiments which were used in this work. In order that conditions be constant these experiments were performed at regular intervals, always in the same place and in the same way. They were all very simple. I could not use experiments requiring cumbersome or expensive apparatus, since there is no psychological laboratory at the hospital and there are not facilities for handling or caring for such apparatus there. Because the patients were in different wards and buildings and I deemed it advisable to carry on the work in the various wards, in order to keep the patient as much at ease as possible and thus get a truer measure of his mental condition, it was necessary that my outfit be portable. These and other existing conditions put narrow limitations on the character of the experimental work. The amount of work also was limited by the capacity of the patient. A standard series of tests was used as a maximum. The time required for this series varied from thirty minutes in some normals to two hours in some dementia præcox patients. The order in which the tests were performed was usually the same, though at times it became expedient to change the order or to omit some of the experiments in order to adapt the work to the condition of a given patient. The order in which they were usually used and the order in which they are here described is as nearly as possible the true psychological order.

DESCRIPTION OF EXPERIMENTS

Test I. *Addition Test*

The addition test used was given as a measure of judgment involving memory and attention. The test was of the speed and accuracy in adding and every precaution was taken to

eliminate errors due to factors other than the disturbance of the processes to be measured. The sum to be added consisted always of two numbers, one above the other with a line beneath the lower number, all printed on white unruled paper in the same type and spacings as here presented. The number of sums used varied according to the previous training and the condition of the person observed. The maximum used was twenty such sums while five was the minimum. Two numbers of four digits each were generally used, but in some cases numbers of one or two digits were used in order to adapt the test to the ability of the subject and the amount of his school training. This factor remained the same for each patient, throughout the series in most cases, the only exception of any importance being in Case L. D. J., as will be shown hereafter. The time required to complete the test was measured with a stop-watch and was recorded at the time of the test on the sheet with the subject's addition results and also his name and the date. The experimenter marked the errors later. This constituted the record of the test and the sheets were preserved for further use in the study of the relative numbers and kinds of errors made.

6 3 5 4
7 2 5 9

Test II. *Cognition Test*

'Marking out A's.' This test has been used as a measure of the time and accuracy of a simple judgment of cognition. In this experiment the subject was given a sheet on which were printed five hundred capital letters, all evenly spaced in thirteen lines and so distributed that they do not form words or syllables. Of these five hundred letters one hundred were A's, distributed irregularly among the others. The subject was required to mark out, i. e., run his pencil through each A. He was then given a sheet with one hundred A's each in the same position as on the original sheet but without the other letters, and was again required to mark out the A's. The time used and the number of errors made (if any) were recorded on each sheet. It will be seen that the difference between the time required for the first

sheet and that for the second sheet will be the time used in finding one hundred A's among four hundred other letters, and one hundredth of this time will be the time required for recognizing an A from the letters among which it occurs. This time varied greatly with different subjects, and for this reason the result of a single test has little significance. The chief value of the experiment is in measuring the variations in a given subject from time to time, and in comparing these variations of the patients with those of normal subjects.

Test III. *Discrimination Test*

This test served well the same purposes as the A-marking experiment. It is Jastrow's experiment for the measurement of reaction time by card sorting. The subject was given a deck of forty cards, of which half had red figures and half had black, (a deck of playing cards from which the face cards had been removed). He was told to deal the cards face downward as quickly as possible, alternating between two piles. The cards were then shuffled and the subject told to deal them face up as quickly as possible, placing each red-figured card on one pile and each black-figured card on another. The time required for each operation was registered and, as in the previous experiment, the difference between the two times is the time required to judge for each of the forty cards whether its figures are red or black. One fortieth of this time is the time required for a single judgment.

Test IV. *Comparative Judgment of Lengths of Lines*

In this experiment a card 125 mm. × 170 mm., having on it a standard black line 100 mm. long was laid on the table before the subject, either at his right or his left as he might prefer, the line being parallel to the edge of the table. Cards of the same size bearing the lines to be judged were then placed before him, one at a time, in a similar position at his left or right, the ends of the two cards (the test card and the standard) being together. The subject was required to judge for each

line whether it was longer, shorter or the same length as the standard line. The lines used were 92, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106 and 108 mm. in length and the entire set was used each time. The standard line was always placed on the same side and the comparison was always made at the same distance and the same angle. Only errors were recorded. A serious objection to this test arises from the fact that different occupations develop different degrees of facility in judging lengths and distances. The subjects exhibit very different degrees of proficiency in this direction, making a comparison of single tests of different subjects worthless. The experiment is of value as a measure of the changes in the condition of a subject from time to time by the comparison of his work on different days.

Test V. *Drawing a Line Equal to a Line Seen*

This test is similar to the last, involving the same factors and also the new factor of motor efficiency. A strip of paper 30 cm. long and 10 cm. wide, having at one end a line 100 mm. long, was placed before the subject and he was told to draw, at the other end of the paper, a line of the same length. He was allowed to compare the line he had drawn and to correct it if necessary to make it the same length as the standard line before him. The same sheet is used for the following experiment.

Test VI. *Drawing a Line by Memory Equal to a Line Previously Seen*

The subject's attention was again called to the standard line and the sheet was then turned over and he was asked to draw a line on the blank page equal to the line he had seen. This test thus involves the factors of the Test IV together with the motor efficiency of the preceding test and the additional factor of memory. These line-drawing tests serve the same purposes as Test IV and show less variation. The value of this also consists in comparing with each other results from the same individ-

ual at different times rather than in the comparing single tests of different subjects.

Test VII. *Auditory Memory for Letters*

A number of letters so arranged as to form no words or syllables was read to the subject. He then tried to repeat the letters in the order in which he heard them. As a second part of this test a new list of letters was read twice to the subject and he tried to repeat these in their order. The mistakes made and the method used in fixing the letters in memory were always noted, together with the lists of letters used. The number of letters used varied with different subjects and with the same subject at different times in order to adapt the test to his ability with the changes in his condition. With normals a standard ten-letter test was maintained.

Test VIII. *Visual Memory for Words*

The subject was given a number of white cards each bearing a word of five letters. He studied these cards for a short time until he thought he could remember the words. The cards were then mixed with an equal number of similar cards, bearing words of the same kind, names of similar objects, etc., and he was told to separate the word-cards he had studied from those he had not seen before. To aid in maintaining constant conditions the time required for each operation was taken with a stopwatch as in this way the subject used only what time he thought was necessary. The list of words used, the time required for each operation, all mistakes made, and the method used in fixing the words in memory, were all noted in the record of the experiment.

Test IX. *Visual Memory for Pictures*

This experiment was performed in exactly the same manner as the preceding one. The cards used were of the same size (8 cm. long and 5 cm. wide) and each had in its center a simple

pen sketch in black ink. The sketches were about 3cm. by 2 cm. The objects represented were domestic animals, carts, boxes, boats, etc., all of which were familiar to every subject. The same records were kept as in the preceding experiment. Particular attention was given the methods used in memorizing the words and pictures used in these two experiments.

Test X. *Motor Efficiency Measurement*

A simple test of motor efficiency was incorporated in this list of experiments since motor efficiency plays a part in some of the other tests used. The test was of the rapidity in tapping on paper with a pencil. A standard ruled sheet was used and the subject tapped as rapidly as possible, making rows of dots back and forth between the ruled lines for thirty seconds. The number of dots made in this time was recorded. As in some of the other tests the difference, even between normal individuals, was so great that the experiment was of value only in the study of the relative variability in individual records and the comparison of this variability in normal subjects with that shown by dementia præcox patients.

Test XI. *Association Test*

This is the association experiment as used by Jung and others. A test word being spoken, the subject speaks the first word or thought coming into the field of consciousness after he perceives the word spoken. The time elapsing between the speaking of the test word and the first motion of the subject to reply was recorded with a stopwatch. The number of words used in a single day varied from 10 to 100. The same words were used with each subject, and my aim was to use as great a number of words as possible and to choose them from widely different fields. This was necessary in order to make the test as near uniform as could be with subjects whose previous training and occupations had been so different. This experiment gives a measure of the speed and accuracy of association. It affords some insight into the disturbance of the processes of memory and judgment. It was also of some value in revealing hidden

associations, thus giving evidence of some facts in the history of the various patients that they could not be induced to give in the course of conversation even by the most careful questioning.

Each of the eleven experiments described above was used to measure the disturbance of one or more processes and, since the conditions maintained were constant, the result should be a true measure of the deterioration of the process under study. A comparison of the results from week to week should show the progress of the deterioration of that process. A comparison of the results of all the experiments for a given week would show the average efficiency of the various processes, the general tone of the work for that week and a study of the changes in tone from week to week should show the changes in the patient's mental efficiency. This experimental evidence has been confirmed by the actions and conversation of the patient, and the statements of the physicians and attendants, all of which have been recorded in order to demonstrate conclusively that it is possible to trace the course of the disease in the curves of the experiments. Such a mass of evidence is uninteresting in itself and cannot be presented in outline. It is sufficient to state, that, while in a few cases the curve of a single experiment may not mark accurately the changes in the general mental condition of a patient, the general tone of the experiments for any day will show the condition of the patient for that day, and its changes from week to week will show the progress of the deterioration or the improvement in the condition of the patient.

CASE HISTORIES OF SUBJECTS

Before proceeding with the experimental results obtained, it may be well to give a brief history of each case, describing the most striking psychoses presented by the different individuals and noting the course and termination of the disease in each case. In order that the reader may better understand the curves by which the results of the experiments are presented (Comparison of Dementia Præcox Patients with Normals), I shall give in connection with the first case reported the tabulated record for that case. This type of record was prepared in each case and

it was from these records, embodying the complete results of the experimental work done, that the curves of the various tests have been prepared.

Dementia Præcox Patients

Case H. E. M., aged 27 years, single and a native of Ohio. This patient had attended school until about 16 years old, completing the first year of a high school course. He then went to work and soon learned the printer's trade and operated for himself a small printing establishment in his home town until the first signs of insanity were noticed. As is so often the case in dementia præcox, the first sign to be noted was that he was neglecting his work, leaving his shop closed while he was taking trips to neighboring cities with no apparent object. He indulged in excesses and in addition was frequently found shamelessly masturbating. Some delusions of a sexual nature were also noticed. As a result he was taken to a private sanatorium in Columbus, and since he became steadily worse he was soon brought to the State Hospital for treatment. It was after he had been a patient there for some months that I first saw him. He was a man of medium height, was rather heavy set, had dark hair, and his eyes were dark and set well back under bushy black eyebrows. His gaze was restless, never fixing long on one point, and even in a moderate light he blinked often—much as does a man on coming from a dark room into a lighter one. When talking he would never look one fairly in the face, but would look down or off in a corner or out the window. In fact he had a guilty, self-accusing look which plainly bespoke foul habits. On the whole, his face was weak and sensual, showing self-indulgence and lack of will power. His hands, like his eyes, were never still. He would nervously pull at his coat, twist a button or pick at his finger-nails, when he had nothing else with which to engage his stubby fingers. In dress he was at first fairly neat but seemed fond of flashy colors. Later he became careless, slovenly, and, finally, very filthy. He was polite and talked readily and rationally about himself, his home life and his work. He did not realize that he was regarded as

insane and believed that he was at the hospital to be treated for a tumor. He exhibited no delusions nor marked abnormal characteristics that would have been noticed by a casual observer. Examination showed however that he had some delusions, and that he had certain well-marked motor disturbances of which cerea flexibilitas was the most striking. He showed no negativism or stereotypy at this time, but as the disease progressed the cerea flexibilitas disappeared and in its place came negativism and stereotypy, illusions and hallucinations. His delusions grew to such an extent that they became the most striking feature of his condition and seemed to form the nucleus around which the other psychoses grouped themselves. Thus at various times he exhibited all the symptoms described by Kraepelin as being characteristic of catatonia (except the stupor). His delusions were often persecutory and were never stable though the same general ideas occurred throughout. They were frequently of a sensual nature and showed his abnormal sexual emotion, which was further evidenced by continued masturbation.

The deterioration was very rapid and at the end of about three months his condition was such that further experimentation was impossible. He then showed marked negativism, stereotypy, loss of memory and apprehension and seemed always completely absorbed in his hallucinations, which were chiefly auditory. Thus he would sit in one position for hours, the muscles of his face twitching and his lips moving at times as he conversed with the voices which he said he heard by 'insulation.' He believed that he had a sweetheart who was staying in a building a few hundred yards away in order to be near him, and he claimed to be able to talk to her and to see her through walls and across space by this power of 'insulation' which she likewise possessed. Likewise there were some other persons who could talk by 'insulation' and who used it to persecute him by telling false stories about him and by calling him names and interrupting him when he wanted to talk to his sweetheart. Thus his delusions centered about these hallucinations and at one time I would find him laughing over something funny he had heard, while at another he would be weeping bitterly because this girl had told him that I had shot his father.

Along with these delusions developed a number of tics—peculiar twitchings of the facial muscles—that he believed were a necessary part of the 'insulation.' These contractions however were of a sort which do not normally occur voluntarily, being for the most part unusual combinations of contractions of the corrugator supercilii, occipito frontalis and orbicularis palpebrarum (producing twitchings of the forehead and eyelid) and of the risorius, depressor anguli oris and levator labii inferioris. In these tics the muscles of both sides did not always work together or equally. Thus one picture (a snapshot) shows a twitch of the corrugator supercilii very much more marked on the left than the right side and at the same time a stretching and depression of the angle of the mouth by the risorius and depressor anguli oris. A picture taken one second later would have shown a different set of contractures since these were not the slow normal contractions of the muscles brought into play which occur as the result of a continued stimulus (volitional) and are known physiologically as tetanus, but corresponded more closely to the true physiological muscle twitch which is produced by an instantaneous stimulation of the nerve supplying the muscle and cannot be produced voluntarily. They did not always accompany either the movements of his lips or the hallucinations of hearing but might accompany either or both. The interference of the hallucinations with the various mental processes is shown in many ways. Thus when listening to the voices he would often fail to hear his name called, or he might know that he had been spoken to but would not know what had been said or asked of him. The retarding effect is shown by the fact that if asked a question he would often sit still for many minutes conversing with the 'voices' but would finally answer the question asked without its having been repeated. Another peculiar disturbance intimately connected with the hallucinations was shown in the repetition of an answer to a question, the interval between the repetitions being completely taken up with his conversation with the 'voices.' For example, when I greeted him one morning he did not answer for a time but finally shook hands with me and replied "Good morning. How are you this morning? I am fine and dandy."

After an interval of about twenty seconds, and without any further words on my part he repeated the greeting and again shook hands. Thus he repeated the same words and actions eighteen times, the interval each time being longer than before and being always occupied with the 'voices.' After the last repetition he became completely absorbed in his hallucinations and gave no sign of hearing or understanding any of the questions I asked him. This condition persisted and made conversation at all times difficult, and sometimes impossible even for his brothers and sisters, who frequently visited him. When he had been in this condition for about two months, that is, at the end of the fifth month of my observations or about one year after the onset of the disease, he was removed to a private sanatorium in a distant part of the state. At the last report of his case a year later his condition remained unchanged except that his dementia was more profound. Thus the disease, in this case, after a gradual onset, ran a course of rapid deterioration with termination in complete dementia.

A study of the family history of this patient reveals no history of insanity of any sort and none of the relatives so far as can be learned are now insane, though many of them show a neurotic condition which may be regarded as predisposing to insanity. Some of the brothers and sisters of the patient were formerly used as subjects in some experiments carried on by an observer from this laboratory and he confirms my statements of a neurotic disposition and further reports that he found them quite suggestible and peculiarly susceptible to hypnotism. Others of the family showed emotional instability, often becoming suddenly and violently angry on slight cause and in other ways giving evidence of a weak, nervous temperament. There is no record of bad habits in either of the parents but the patient himself has led an intemperate life, using alcohol to excess and indulging in promiscuous intercourse. His sexual nature has probably always been abnormal and there is history of long continued masturbation. He denies having had syphillis and there is no evidence of his having had any venereal disease.

The experiments used with this patient were at first the standard tests as used with normal subjects but as deteriora-

Table I (Case H. E. M.)

Tests	Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13
Test I Addition Test	Number of sums	20	20	20	20	20	20	20	20	20	20	20	20	20
	Number of errors	4	3	4	1	3	2	1	2	3	3	3	2	7
	Time of all sums	331	251	240	217	382	273	307	480	335	557	408	530	950
	Time of ten sums	165	125	120	108	191	136	153	240	167	278	204	265	475
Test II Marking Out "A's"	Time marking A's No. 1	132	119	132	155	170	134	141	140	149	129	150	186	360
	Number of errors								1				1	
	Time marking A's No. 2	72	56	63	69	81	64	68	75	64	70	43	89	139
	Number of errors													
	Time finding 100 A's	60	63	69	86	89	70	73	66	85	59	107	99	221
	Time of simple piling	37	35	37	37	34	45	39	39	34	46	38	45	×
	Number of errors													
Test III Discrimination Test	Time sorting for color	49	52	49	57	60	73	56	95	59	72	56	95	×
	Number of errors												2	×
	Discrimination time (40)	12	17	12	20	26	28	17	56	25	26	18	50	×
	Discrimination time (100)	30	42.5	30	50	65	70	42.5	140	62.5	65	45	125	×
Test IV "Lines."	Upper limit (perception)	—	102	—	106	100	103	101	103	—	105	103	—	×
	Lower limit (perception)	—	106	106	106	—	—	—	104	108	—	—	—	×
Test V Lines compared.	Length equal to 100 mm	102	104	100.5	107.5	108	103	104	107	99	102	108	112	104
	Error	2	4	.5	7.5	8	3	4	7	1	2	8	12	4
Test VI. Line memory	Length equal to 100 mm	97	92	101	109	100	107	104	99	91.5	100	95	100	107
	Error	3	8	1	9		7	4	1	8.5		5		7
Test VII Letter Memory (Auditory)	Number of letters No. 1	10	10	10	10	10	10	10	10	10	10	7	10	×
	Number of errors	8.5	4	6.5	4	5.5	2	4.5	3		1	4	3.5	×
	Number of letters No. 2	10	10	10	10	10	10	10	10	10	10	10	10	×
	Number of errors	3	3.5		1	12.5	4	4	3	4.5	2	3	9	×

Test VIII Word Memory (Visual)	Time studying cards	145	75	20	43	130	125	100	–	75	20	25	15	×
	Time sorting cards	30	25	15	22	65	46	58	–	28	80	40	105	×
	Number of cards used	10	10	10	10	10	10	10	10	10	10	10	10	×
	Number of errors	2	1	2		2	1		1		2	2	5	×
Test IX Picture Memory (Visual)	Time studying cards	65	57	48	50	45	–	47	120	45	48	53	15	×
	Time sorting cards	57	30	35	35	–	–	55	50	45	80	37	46	×
	Number of cards used	10	10	10	10	10	10	10	10	10	10	10	10	×
	Number of errors	1		1	1	5	1	1			2		1	
Test X Tapping	Number of dots made in thirty seconds	179	165	174	180	147	153	145	153	151	163	169	132	152

NOTE.—Time is always given in seconds.

Distances or lengths are given in millimeters.

× signifies that the patient's condition was such that the test so marked was not performed.

– signifies that accurate measurement could not be obtained.

Zeros are not recorded in error columns. When no errors were made the error space was left blank.

In the addition test the time of ten sums was found since this was a convenient standard to which the results with all subjects could readily be reduced to uniformity for tabulation.

In the A-marking Test No. 1 refers to the sheet of five hundred letters and No. 2 to the sheet of A's only.

The calculation of the time of 100 discriminations in Test III was made to secure the ready reading of the time of a single act of discrimination, and for convenient comparison with the results in Test II. The upper limit mentioned in Test IV is the line least exceeding 100 mm. in length which was recognized by the subject as being longer than the standard line. It is the point beyond which he was absolutely sure the lines shown were longer than the standard. The lower limit was the point beyond which he was sure they were shorter. Errors in tests V and VI is difference in millimeters between the standard line and the line drawn.

In Test VII No. 1 the list of letters was read once, and in No. 2 the list was read twice.

tion progressed they were made less difficult as shown in the table of the experiments presented herewith:

Case L. D. J., aged 25 years, single and a native of Ohio. The patient had spent all his life on a farm in an undeveloped district, distant from any cities of even moderate size and had never been on a railway train prior to the time he was brought to this institution. He had received but a poor education, having attended school but three winters. The remainder of his time had been spent in the routine work of the farm. Of the conditions of his home life and his work nothing is known nor have we any facts concerning the onset of the disease. The only data obtainable are those gotten by questioning the patient and their value from a scientific standpoint is, of course, questionable. He states that his habits have always been regular, that he has never been addicted to the use of drugs or alcoholic beverages and that he has never had any venereal disease. He says that the habits of his parents were good and that neither of them used drugs or alcohol. His mother and three of his grandparents died of 'paralytic strokes,' but none of the other relatives have ever shown any signs of 'paralysis' or insanity. His father, his brother and two sisters were all living and in good health at the time he was brought to this hospital. Since that time he has neither seen them nor heard from them.

When admitted the patient was in good physical condition and his mental aberrations were not such as would attract the attention of the casual visitor. He was short and rather heavy and had a round smiling face and a square firm jaw that indicated aggressiveness. He was not talkative and his answers to questions were always concise and to the point. He was polite and obliging but did only what was asked of him as contrasted with Case H. E. M., who was always ready to offer his services (in the early stages of the disease). The ward physician's provisional diagnosis in this case was hebephrenia and for a time he showed no symptoms which would seem to invalidate this diagnosis, but it was not long before the characteristic symptoms of catatonia began to appear. What had at first seemed like mere reticence developed into negativism and the patient refused to answer questions. Ecolalia was found to some extent

and this together with mutism and negativism put a stop to experimentation. Afterward he presented the pressure of activity found in the excited states of catatonia, was violent at times and often exhibited stereotyped movements of various sorts. Cerea flexibilitas was never present.

When first admitted to the hospital the patient was perfectly oriented, had fair memory and judgment and showed no marked disturbances of volition or emotion. But with the progress of the disease memory and judgment deteriorated rapidly until after a year in the hospital the patient was completely disoriented, did not recognize anyone he had met since coming to the hospital, and could not remember the name of his home postoffice, the year or day of his birth or any of the fundamental points of his home life or his experiences at the hospital. Correlated with the deterioration of memory and judgment, and accompanying it, came grandiose delusions of an unstable and unsystematized character. The patient believed he had traveled thousands of miles, had been to South Africa, that he was a great hunter, was very rich, and that the hospital was a fine hotel at which he was staying for a few days' rest. He seemed to have lost completely the idea of time and could not tell the day or the month, nor had he any idea of the time interval between ordinary events such as breakfast and dinner. Thus he passed into a stationary condition in which his negativism and stereotypy, his hallucinations and delusions gradually disappeared. In the meantime the patient had lost flesh, and, like most patients of this class, had lost some of his former decisiveness and poise. His movements were awkward and slow, and much of his strength was gone. His old smile was gone and his expression was blank and dazed like that of one who has just been awakened from a deep sleep. Thus he would sit for hours apparently hearing nothing, speaking to no one, and staring fixedly at the floor. This condition has shown little change for a year and will probably persist until some intercurrent disease overcomes the patient. It is the terminal stage of dementia in which most of these cases end.

Case O. O. L., aged 22 years, single and a native of Ohio. Both parents have been dead for many years and the causes of

their deaths are unknown. Since their deaths the patient has lived most of the time with an older brother, who, like himself is single and who keeps house for himself on a farm about ten miles from the nearest city. The present attack is not the first for this patient. He has been at this hospital twice before, remaining each time for a few months and then returning to his brother. His condition for the past year has been such that if he had a good home to which he might go he would be discharged immediately. But the physicians do not deem it advisable to allow him to return to the conditions that seem to exist in his brother's home.

The history of the onset in this attack, as in the two preceding attacks, is rather indefinite since no authentic report was made in the commitment. The patient seems to have no idea of the causes of the attacks nor does he remember the events preceding his imprisonment in the county jail ten miles from his home. He remembers in a faint and rather confused fashion what took place at the jail and some of the particulars of the trip to this city, but when questioned on these points does not always tell the same story. This type of onset seems to have characterized each of his attacks. Since he has been at the hospital his memory has improved as have also his judgment and motor efficiency. Though the patient has never shown marked delusions there is evidence that he had hallucinations and illusions in the early stages of the attack. These have entirely disappeared and he has now reached a comparatively normal stage in which he remains without change of any sort. Since reaching this stage he has been employed in one of the kitchens of the institution and has been granted privilege to walk upon the lawn during daylight hours. He is now probably as nearly normal as he has ever been since his first attack some years ago.

Since his condition was already much improved when I began the study of the case the experimental evidence serves only to demonstrate the gradual improvement of the various faculties with occasional short periods of deterioration. Some departures from the usual conditions of the experiments were made necessary from the fact that the patient had attended school but three years, had never learned to add numbers of more than

two figures and could not read or pronounce many of the words used in some of the tests. Thus in the addition test numbers of one digit were spoken and he answered with their sum. In the word-memory test it was found that he must spell out each word and that he was not familiar with many of the words used with the other patients. For this reason the words used were carefully picked and were always spelled and pronounced for the patient while he held the card in his hand looking at it and trying to fix it in his memory. Fewer letters were used in the letter-memory test than with other subjects and in one or two other tests minor details were changed to adapt the work to the ability of this patient. But the conditions remained constant throughout the series and the changes made are of little importance in the final consideration and comparison of results since the changes made served only to adapt the experiments to the previous training of the patient and his mental capacity under normal conditions.

Case A. B. H., aged 30 years, single and a native of Ohio. This patient was engaged in farming previous to the time of his commitment and had been at this institution for five years when the experimental study of his case was begun. When brought to the hospital he was very violent and had to be confined to a strongroom for several weeks. Memory and judgment were poor and he was completely disoriented. He now remembers nothing of the onset of the disease, his trip to the hospital or the weeks of his confinement, and, as careful records of such cases were not kept at that time, we can not obtain a complete history of the case. It has been learned however that after some weeks he began to be less violent and better oriented and to slowly recover his memory and judgment. About this time some delusions began to develop. Chief among these was the idea that he must not eat solid food and it was found necessary to tube-feed him. Though the other delusions disappeared with his continued improvement, this one persisted and, learning to tube-feed himself, he continued to refuse solid food. After some months he was so improved that he was transferred to another ward and was assigned certain duties in connection with the care of the ward. These duties he performed faith-

fully and he was soon rewarded with many privileges that could not be granted to the other patients. Thus he continued for the six years during which he was a patient at the hospital and in the last year of his residence there, the year during which I studied his case, he showed no striking symptoms other than the delusion regarding his food and this was slowly disappearing. During all this time he seemed anxious to go home and asked the physicians for his discharge a number of times. Each time he was told that as soon as he would begin to eat food as other people did he could go home. But even such an inducement as the chance to go home would not bring him to eat solid food and he continued to use his tube. At last he decided to run away and go home and he did so one afternoon, taking his tube with him. That he should do this when by eating solid food he could obtain permission to go home and run no risk of being brought back is characteristic of the condition of such patients. Here we have a man who has sufficient judgment to plan an escape and to make his way home, a distance of about seventy miles, quickly and safely and without attracting sufficient attention to cause his apprehension, a man who, to the casual observer, would appear quite normal, as he must have to those whom he met on his trip home. His delusions have so far disappeared that there is no longer evidence of them and he can assign no valid reason for not eating solid food. The use of the tube is simply a habit now. It was formed when the patient had a reason satisfactory to himself for not eating solid food and the habit persisted after that reason had disappeared because the patient's judgment was not strong enough to see the incongruity with the rest of his life. It is the same weakness of judgment which underlies the inadaptability of G. E. N. to his new environment when he is moved from one ward to another and causes him to call his new attendants by the names of those who cared for him on the ward from which he had just been moved. It is the weakness which underlies the inadaptability to environment of all early dements and such evidence of it as this patient showed in taking his tube home with him was sufficient to show that he had not yet fully recovered and he was brought back to the hospital. A few months later he began

to eat solid food and after a few weeks he was discharged from the institution as cured.

The experimentation in this case brings out strikingly the stationary condition the patient had reached before I began the study of his case; and yet it shows the weakness of the processes of memory and judgment which remain as after-effects of the disease and furnish the chief factor in predisposing such a patient to another attack. The influence of changing conditions upon such persons is well shown and may be read in the variations in efficiency from week to week as represented in the curves of the experiments. These curves show neither a marked improvement nor deterioration but a mean variation much greater than that found in normal subjects. The experiments were modified exactly as in case O. O. L. except that in the word-memory test the words were not spelled out nor pronounced for the patient. Uniform conditions were maintained throughout the series of tests.

Case E. A. F., aged 26 years, single and a native of Ohio, but both parents are natives of Germany. The parents of this patient are living and in good health, and there is no history of insanity in the family. The onset of the disease in this case was characterized only by the appearance of delusions of a grandiose nature, accompanied by some hallucinations or illusions. These delusions persisted and formed the only striking feature of the disease during the time the patient remained at this institution. The symptoms correspond closely to those described as characterizing the paranoid form of dementia præcox[1] Judgment and memory were but slightly affected except as concerned the substance of the delusions. There were no physical symptoms and motor efficiency seemed normal. As is usual with such cases deterioration was very slow and no marked changes could be noted for the time during which the experimentation was carried on and but little deterioration could be seen in the two years he remained at this hospital. At the end of this time he was transferred to an institution in another part of the state and further observations were impossible. The

[1]Defendorf, "Clinical Psychiatry" (Second Group of the Paranoid Form of Dementia Præcox), p. 260.

tests used with this patient were the same as those for normal subjects and the conditions maintained were constant. The curves representing the results of this work bear out very closely Diefendorf's statement of the character and course of the disturbances of the psychic processes in this class of cases.

Case A. L. L., aged 27 years, single and a native of Sweden. The patient attended school in Sweden until he was fifteen years of age, at which time he came with his mother to this country. For the first three years after his arrival in this country he was employed in a factory in Binghamton, New York, and in this time he became addicted to the excessive use of beer and other alcoholic beverages. On leaving the factory at Binghamton he went to Chicago, where for about a year he was employed at various sorts of labor, most of the time in the packing houses. At the time of the Spanish-American War he enlisted in a regiment from Chicago and went to Cuba. Becoming sick he was discharged and returned to Chicago. He staid there but a short time and went to Pittsburgh, where he was employed for some months. From this point he started for the South and traveled aimlessly through several of the Southern States, remaining in one city only long enough to get money to go on and riding often from one place to another on freight trains. Finally he returned to the North and worked in several of the large cities, being much of the time in Pittsburgh and Chicago. Eventually he came to this city, where his father had been employed for many years in one of the large tailoring establishments. While here he staid at his father's house and put in his time learning his trade as a tailor. He was at this time about twenty-four years of age. While in this city his father would not allow him to become intoxicated and many quarrels resulted. After a few months here the son again went to Pittsburgh and from there to Chicago, where he remained but a short time. He then went to Seattle, Washington, and after staying for a few months with a brother there he traveled from place to place through Washington, Oregon, and California, just as he had traveled in the South a few years before.

While at San José (Cal.) he began to write peculiar letters to his father. In each letter he asked for considerable sums

of money and the letters give other evidence of the development of delusions about this time. A short time afterward he wrote to his father from San Francisco stating that he was sick. A few weeks later he was taken to the Mendocino State Hospital[1] at Talmage, California. His committment papers stated that he had had syphilis, gonorrhea and chancre. When examined his pupil reflexes were normal and his knee reflexes were dull. On the second day he had a peculiar pseudo-cataleptic attack during which he could not be aroused. The following day he became very noisy and disturbed and this condition lasted for three days. His improvement from this time was uneventful and he was discharged as cured six weeks later.

On leaving the hospital he returned to this city and went to work in the tailoring establishment at which his father was employed. He did not work regularly however and was intoxicated much of the time. He had many delusions of persecution and of a grandiose nature. He believed that people were trying to murder him with gas, that he was to be imprisoned in the basement of his home, etc. Upon going to the tailoring shop one afternoon he demanded $15,000 for the work he had done that day and became very violent on being refused the money. Realizing that he was insane the foreman had him taken to the city prison for the night and two days later he was committed to this hospital. The interval between his discharge at the Mendocino State Hospital and his commitment to this hospital was forty-seven days.

Of the events connected with his committment and his removal to the hospital he can remember but little, exhibiting in this respect much the same condition as cases O. O. L. and A. B. H. When admitted to the hospital his judgment was fairly good and memory was good except as concerned the onset of the disease. During the first year his delusions gradually disappeared while memory and judgment deteriorated steadily. When I began the study of this case memory for recent events, judgment and apprehension were fair and the patient could tell

[1] I am indebted to Dr. E. W. King, Medical Superintendent of the Mendocino Hospital for the Insane, for the facts concerning the commitment of A. L. L. to that hospital, his condition while there and his discharge from that institution.

a broken but fairly well connected story of his travels and his adventures in the various cities he had visited. The patient exhibited much the same condition as L. D. J., sitting usually in the same place, speaking to no one unless spoken to, and paying little or no attention to what was going on about him. His figure was rather slight and his shoulders were round and when he walked he stepped carefully as though afraid of making a sound that would disturb some one. His complexion was sallow, his hair very dark and his eyes were weak and shifty and were set well back under dark eyebrows. His forehead was low, his nose rather sharp and thin, and his mouth and chin betrayed a weak, vacillating disposition. His face never expressed either strong likes or dislikes, and, in general, it resembled very much the 'washed-out,' despondent expression so often seen in the later stages of paresis.

With the progress of the disease memory, judgment and apprehension deteriorated rapidly and volition became so far disturbed that the patient found it impossible to give a continuous account of any series of events and could only answer simple questions. By questioning him carefully it could be shown that he had all the points necessary for an account of the event in question but the disturbance of volition was such that he could not combine his statements into a story. This is typical of the disturbances of volition in dementia præcox. In the meantime his emotional processes had so far deteriorated that nothing could change the despondent attitude which he maintained regardless of his surroundings. Thus he reached a terminal demented state quite similar to that seen in cases H. E. M., L. D. J. and in case G. E. N., which has not yet been described.

Case C. A. V., aged 24 years, single. The father and mother and several brothers and sisters of this patient are living and in good health and there is no history of alcoholism or insanity among any of the relatives. The patient had the usual diseases of childhood and has been rather sickly most of his life. He had a first attack when nine years of age and his physician regarded the present attack as a relapse from the effects of the first. The exact nature of this early attack cannot be ascertained. The

patient received a common school education but had no opportunity to attend a high school. His occupation since leaving school has varied from time to time. Much of his time has been spent as a lineman in telephone, telegraph and traction construction, though he has been employed at times in various glass works, factories and foundries. The habits of the patient have always been good and there is no history of alcoholism or other excesses. A careful study has failed to reveal any sufficient cause for insanity. With a great deal of sickness as a predisposing factor it may have been due to worry and overwork, with insufficient care as to physical condition. Or this may be one of those cases in which a mind seems to go wrong without a sufficient external cause.

When the first symptoms of the present attack were noticed the patient was placed in a private sanatorium in this city. Two months later he was transferred to this institution for treatment and was examined at once by the physician in charge. His memory was found to be poor and he was unable to answer correctly many of the questions asked him concerning his home life and the events preceding the attack. Volition was somewhat disturbed and the emotional processes were affected. His mood was depressed and he showed no desire for the society or conversation of the other patients. He had no delusions or hallucinations at this time. He neglected his personal appearance and showed very little voluntary activity. For the first six months at the hospital he seems to have remained in this depressed mood with but little deterioration and his condition at the end of this time was but little changed. It was then that I began the study of the case.

About this time the deterioration became more progressive and continued for about four months, when the disease reached a crisis. Memory, judgment and orientation seemed completely lost. The patient became violent and was confined to a strong-room. Suddenly convulsive contractions of the muscles, particularly of the limbs, became a feature of the disease. Thus the patient would often, without warning, crush any object happening to be in his hand at that moment, as, for example, a tin cup from which he might be drinking. Fantastic halluci-

nations and illusions developed, followed by unsystematized delusions some of which were of a religous nature while others betrayed a perversion of the normal sexual instincts. During this time conversation was impossible and much of the time the patient muttered or shouted incoherent sentences. He often showed very typical examples of rambling thought, flight of ideas, etc. Thus he would talk for ten minutes at a time, the last word of one sentence suggesting the first word of the next, sometimes by similarity of sound, sometimes by association of meaning, but without the slightest association of ideas between the various sentences. This condition persisted for three weeks, at the end of which time the patient began to improve and the improvement in his condition for the four months following was as rapid as had been his deterioration. At the end of his fourteenth month in the hospital he was discharged as cured and left the institution in better mental condition than any discharged dementia præcox patient that I have ever seen.

The experiments used were the same as with normal subjects and the experiment curves portray strikingly the course of the deterioration and the recovery. It must be noted that for the ten weeks during which the patient's condition was most unfavorable no experimentation was possible, as shown in the break in the curves for this time. The last time the tests were performed was some weeks after the completion of the series proper, being on the day before the patient left the hospital. This was done to see how closely his work would approximate that of the normal subjects. In this last test some allowance must be made for the fact that in the weeks during which no experiments had been carried on the patient had lost some of the results of practice, as seen in the last tests of the normal subjects, and comparison should be made with the earlier tests of the normal subjects.

Case G. E. N., aged 23 years, single. Both parents are living and in good health and there is no history of insanity in the family. The father uses alcoholic liquors in moderation but rarely becomes intoxicated. The patient has used alcohol to some extent but has never been intoxicated.

The patient attended school and did creditable work but after

finishing the fifth grade he left school and went to work as a messenger. Later he entered the employ of a pottery company as an unskilled laborer. He lost this position some time before his commitment to the hospital, and, at first, he was inclined to attribute his troubles to worry over this matter. The physician in charge of the case seemed to regard masturbation as the cause of the disease and to attribute the loss of his position to the onset of the disease and the consequent inability to perform his duties. When the patient was about nineteen years of age delusions began to develop. He believed that to eat certain kinds of fruit was committing a terrible crime and that he was committing murder in splitting kindling and in doing certain other kinds of work about his home. These delusions soon attracted the attention of his parents and friends and brought about his commitment to the hospital. During the first two years of his confinement at the hospital the deterioration had been rather rapid and had about run its course so that at the beginning of his third year at the institution, when I commenced the study of the case, he had reached the terminal stage in which deterioration is very slow. At this time the patient was poorly oriented and showed considerable disturbance of memory and judgment. He showed very little voluntary activity and the extent to which the emotional processes were affected was evidenced by frequent mirthless laughing at unexpected moments and without the slightest cause that could be assigned by the patient himself or detected by the most careful observation. This patient has never shown the despondency that characterizes so many of the early dements. The same mental condition has been maintained for the two years during which the case has been under observation and in the year covered by the experimental study no important change took place in any of the psychic processes. There were a few short periods of increased deterioration, always followed by a return to the former state. On these occasions the patient was always much disturbed and, in general, presented the same symptoms as did C. A. V. in his excited state. At such times he was usually talkative and profane and displayed flight of ideas and ecolalia. He also seemed to be completely disoriented and judgment and memory

disappeared almost entirely for the time. These attacks rarely lasted long, though sometimes the patient did not completely recover from their effects for some weeks.

When last seen he had been at the institution for about five years, though he looked but little changed from the time when I first began to study his case three years before. He is of medium height, rather slight of figure and moves slowly and clumsily like an awkward boy of fifteen. Like A. L. L. he always walks with apparent care as though to avoid making a noise. His hair is brown and his eyebrows are rather thin; his eyes are blue and show the characteristic shifting from one object to another. His mouth lacks firmness and is often set in a meaningless grin. His expression is that of a boy, not a man, and there is about it always a look of fear like that of an animal habitually hunted. If spoken to suddenly or otherwise startled he will jerk sharply as though expecting to be struck and when addressed harshly he cowers like a whipped dog and his face takes on, for the moment, a pleading expression, but the next moment it is forgotten and he is again doing the thing for which he has just been reprimanded. That he has no cause for fear is shown in the fact that he has always received the best of treatment and is quite a favorite among the attendants and patients. It is merely one of the evidences of the disturbed emotional state resulting from the deterioration. Unlike A. L. L. and L. D. J. he does not sit quietly by himself but walks about the ward, talks to the other patients and sometimes pushes one of the padded weights used for polishing the floors. His hands are never still and he is continually picking at the buttons on his coat or playing with bits of trash which he picks up about the ward. His conversation too is characteristic. His voice is rather high-pitched, having never entirely changed and he always speaks in the undertone so typical of the early dement. Usually one must stand quite near him and listen closely in order to understand what he says. As already mentioned he exhibits ecolalic and ecopraxic tendencies and shows marked recurrence of certain words and expressions. Thus one morning when I talked to him everything was fourteen feet long or fourteen feet high or was in some way connected with the number fourteen.

Another feature of his conversation is his tendency to relate over and over certain adventures of his early life, describing such events in minutest detail. But regardless of the subject on which the conversation is started he is pretty sure to end it with a discussion of something to eat, his favorite topic being "soup beans." Thus his conversation, like his actions, is that of a boy. One observing him now, without having seen the earlier stages of the disease or knowing the history of the case, would judge him a case of arrested development rather than deterioration.

The experiments were simplified to adapt them to the condition of the patient and at times his condition was such that no experimentation was possible. This is shown in the curves by breaks at the places where the work could not be carried on. The curves in this case are of interest as showing the instability and great variation in the mental condition of a patient in the terminal or demented stage of dementia præcox.

Normal Subject:

Subject A, male, aged 23 years, single and a native of Ohio. At the time of the experimentation this subject was a senior in the university and a candidate for the B.A. degree. He had had some previous psychological training and, at the time this work was carried on, was engaged in experimental work in the psychological laboratory, as were also subjects B and C. With subject A the series of experiments was performed once each week for ten weeks. The conditions maintained were constant, the tests being always the same and always performed in the same order, at the same place and at the same hour and on the same day of the week. The experiments used were the ones already described and were performed exactly as described. The curves appear in the "comparison of normal subjects with dementia præcox patients" which is to follow and in which the curves of the normal subjects are contrasted with those of the patients.

Subject B, male, aged 22 years, single, a senior in the university and, like A, a candidate for the B.A. degree. This young man showed some well marked temperamental peculiarities

and was, to a certain extent, lacking in the stability of character to be expected of a senior in the university and a man of his age. He did not have a definite object in view in his college training, as was shown by his selection of studies, both at this university and at the college which he had attended for two years before coming here. His intention was to prepare himself to teach, but what to teach he had very little idea. But withal, he was sufficiently normal for my purposes and, since he was working in the laboratory of experimental psychology, was found a very convenient subject for study since standard conditions were much easier to maintain there than with normals elsewhere. As with subject A the conditions maintained were standard throughout. This subject performed the series of tests once each week for nine weeks.

Subject C, female, about twenty or twenty-two years of age, single, and a sophomore at the university. She showed some peculiarities but they were not such as would affect the value of the results for comparison with those of the patients. As with the other normals all conditions of the work remained constant. The most striking feature of this subject's work was a higher degree of motor efficiency than was found in the other normals.

Subject D, male, aged 27 years, single, and a native of Ohio, but of German parents. This subject seemed normal in every way and in two years' acquaintance, a part of which time I was very intimately associated with him, I observed no abnormal or unusual characteristics. He is of good moral character and of average intelligence. In education and social relations he approximated as closely as possible the social class of the abnormal subjects. This subject attended school but a few years, going out early in life to make a living for himself. When 16 years of age he became a telegraph operator on one of the busiest railroads in this state and since that time he has been constantly employed in this capacity, the only exception being when he was employed as a locomotive fireman for a few months some years ago. During all the time he has been an operator he has worked twelve hours every night with occasional vacations of two or three days. However for a few months before this examination was made and during the time the experiments

were carried out he worked in the day instead of the night. It will readily be seen then that his habits have always been very regular and, since his work brings with it a certain amount of exercise his physical condition is usually good. At the time of this series of tests he was in the best of health. He uses tobacco in moderation and alcoholic beverages sparingly, is never intoxicated and has never used drugs of any sort.

This subject being employed as he was, it was impossible to perform the tests in the daytime as was done with the other subjects and instead the work was carried on at night at his room. The conditions maintained were constant. The time of day for beginning the work and the amount of time required for its completion never varied; the place, the temperature and the light conditions were always the same. The experiments were performed exactly as with the other normal subjects. The only variable introduced was the difference in the degree of fatigue produced by his day's work on different days. Thus the curves of this subject represent the most accurate results it has been possible to obtain, and since the subject belongs to the same social class as the patients under study these curves are more valuable for comparison with those of the patients than those of the students at the university.

COMPARISON OF DEMENTIA PRÆCOX PATIENTS WITH NORMAL SUBJECTS

In beginning this comparison of the abnormal with the normal we shall first make a comparison of the various processes in the two classes of subjects as shown by the results in the experiments performed. These results have been presented as far as possible in curves which are so arranged that an upward direction of the curve indicates improvement or increased efficiency of the process under consideration while a descent in the curve marks decreased efficiency or deterioration. The numbers at the left of the figure indicate the value in time or per cent or such other unit as shall be stated for the given experiment. Since the tests were performed regularly at intervals of one week the curves correspond exactly in time, and the numbers at

the top of the figure indicate the number of the week in which the results were obtained, as first, seventh, tenth week, etc. Since the character of the efficiency-measure varied so much in the different tests it was found impossible to arrange a uniform scale by which the results of all the experiments might be presented and the scale has been varied in whatever way seemed best adapted to the clear and concise presentation of the results obtained.

Taking first the processes of mental elaboration we shall begin with the results of the first three tests described, the addition test, the A-marking test and the card-sorting test. The results of each of these experiments have been reduced to curves which indicate the relative efficiency of the processes involved as measured by the time required to perform correctly a single act of perception and judgment. Thus in the addition experiment (see figure 1) the point marked by the curve at any given week indicates the time in seconds required for a single addition such as the one indicated here, the process of 'carrying' not being taken into consideration in this curve since by the methods used in this experiment it was impossible to detect the errors made in carrying the left-hand digit of the sum of one column to add it to the sum of the next column.

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  7
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(1)6
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In the A-marking curve (figure II) the time indicated is the time required for recognizing one A from the four other letters among which it occurs. In the card-sorting curve (figure III) it is the time required for judging whether a single card held in the subject's hand has red spots or black.

Studying first figure I, it will be seen that the first four cases, (cases H. E. M., L. D. J., O. O. L., and A. B. H.) are presented together, the same base line being used for all four of these curves. Likewise cases E. A. F. and A. L. L. are presented together as are also cases C. A. V. and G. E. N. The normal curves are all presented separately, each having its own base line. As stated above the number of seconds is marked at the left of the figure and the numbers of the weeks are noted at the top, making the value for any given week easily read. Thus in the first week H. E. M. took 4.35 secs. for a single addition

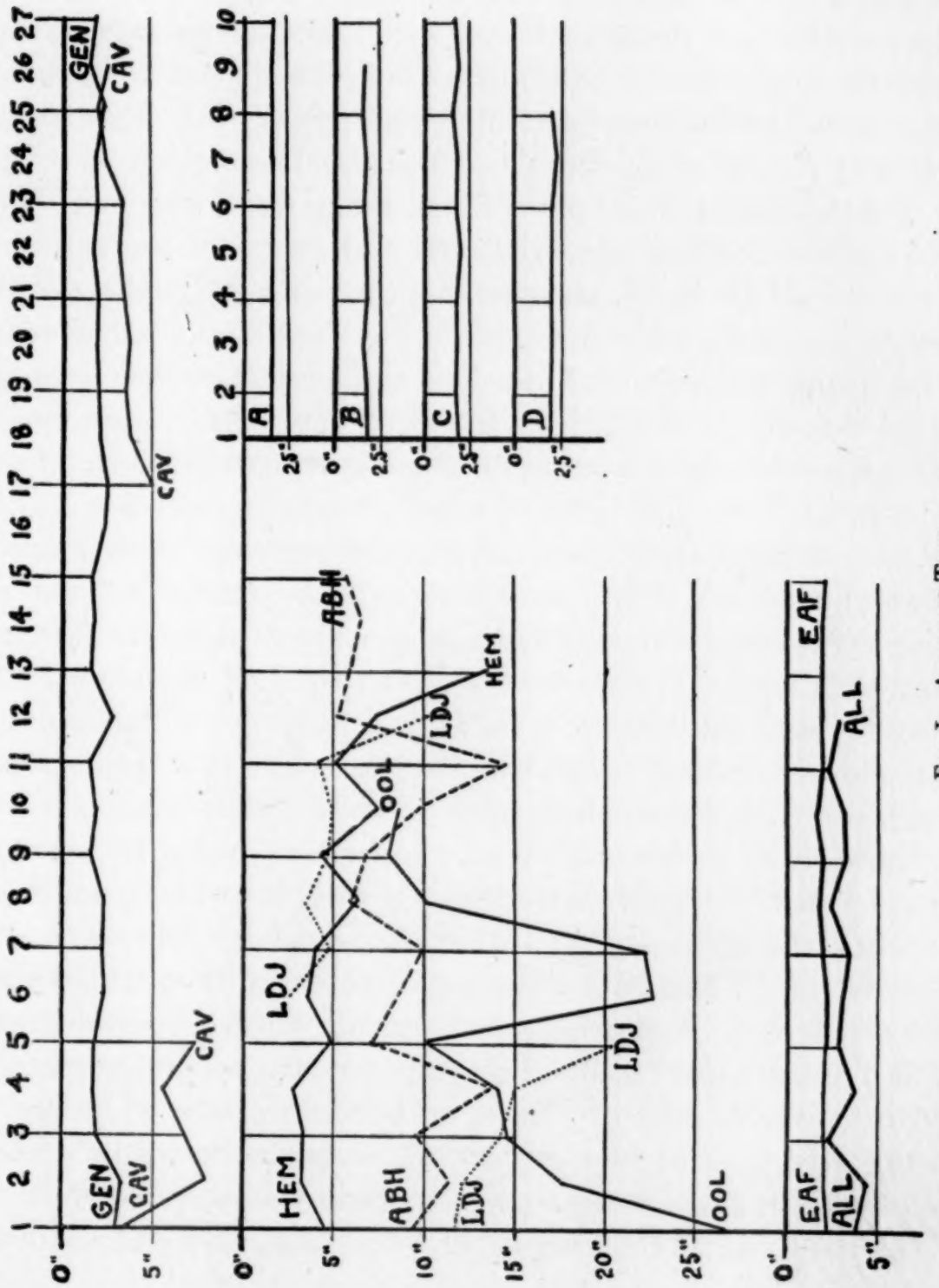

FIG. I. ADDITION TEST.

while in the fourth week he used 2.75 secs. and in the thirteenth or last week of his series he took 13.02, these figures being taken from the table from which the curve was drawn.

The first striking difference to be noted between the curves of the normals and those of the patients is the irregularity of the latter as contrasted with the almost unbroken curves of the normal subjects which appear almost as straight lines, denoting a uniform degree of efficiency. This variation which characterizes the curves of the patients takes different forms in different cases depending upon the type and course of the disease. Thus in case H. E. M. we may note the downward tendency of the curve marking the deterioration of the processes involved. The abrupt descent toward the end of the curve marks the very rapid deterioration which ended in a state of such profound dementia that further experimentation was impossible. For case L. D. J. we find a curve which, beginning with a time of 11.77 secs. for a single operation descends very rapidly to a time of 20.41 secs. in the fifth week at which time it was found that the patient could no longer carry on the standard tests. Beginning then with the sixth week this subject used the single digit sums as used with cases O. O. L. and A. B. H. Thus a new curve for this patient begins with the sixth week at 2.72 secs. and continues to descend, though more slowly, with slight ascent in the eighth and eleventh weeks and ending with the abrupt descent to 10.17 secs. in the twelfth week, at which time the patient's condition was such that the tests were discontinued. Case O. O. L. was one of those patients who have remissions (see case history), and the ten weeks during which I experimented with him were marked by rapid improvement as demonstrated by the upward trend of the curve, beginning with 26.66 secs. in the first week and ending with 8.3 secs. in the tenth. The descent of the curve in the sixth week and the long time required in the sixth and seventh weeks (22.5 and 22.0) may be regarded as characteristic of the unstable condition, the weakness of the mental processes which remains even after a patient seems to have recovered entirely and which probably forms the basis for another attack after such patients have left the hospital as cured. Case A. B. H. was quite similar to O. O. L., the patient having

reached a stationary condition characterized only by a single delusion. But the enfeebled condition of the processes involved was such that they were easily affected by external stimuli and as a result the efficiency varied greatly, giving a very irregular curve with ascending trend due to the improvement with practice and the slow improvement in the condition of the patient.

Case E. A. F. presents a curve which approaches in regularity those of the normal subjects and in this respect confirms the observations of the leading psychiatrists in regard to patients of this class. This is even more strikingly demonstrated in some of the other curves to be presented for this case and it is clearly shown that the efficiency of the various mental processes of this patient approaches most closely that of normal subjects of the same social class. Cases[1] A. L. L. and G. E. N. belong to another class, their curves presenting the same characteristics. Both of these patients are in the terminal stage of the disease in which deterioration is very slow or has ceased entirely. These patients are in their deteriorated condition, like those who have apparently recovered, but to a much greater degree, affected by the conditions about them such as the weather, their physical condition or any change in their surroundings, etc. This is nicely demonstrated in case G. E. N. whose curve shows 3.32 for the maximum time (second week) and 1.73 for the minimum time (in the ninth and twenty-fourth weeks) and presents a continual variation between these two limits. In case A. L. L. we have the same condition, the limits in this case being greater with 4.29 as the maximum (second week) and 1.65 as the minimum (third week). Such irregularity is typical of patients in the terminal stage of dementia præcox and the curves of cases A. L. L. and G. E. N. are typical curves of the mental efficiency of patients in this stage of the disease.

The curve of case C. A. V. is of especial interest since it presents experimental data concerning the course of the disease, the deterioration and the improvement in the condition of a patient who passed rapidly into a state of extreme dementia, in which he remained for a few weeks, and from which he recovered to such an extent that he was discharged from the hospital as cured (see case history). Thus for the first few

weeks the course of the curve is downward to the point at which it is broken (fifth week), the point where the condition of the patient became such that he could no longer perform the experiments. The curve begins again however in the seventeenth week and continues unbroken to the twenty-fifth week. The last test was performed some weeks later. The course of the curve during the last few weeks is irregularly upward, showing not only the improvement, the increased efficiency, but the irregularity due to the persisting weakness as was noted in cases O. O. L. and A. B. H., the other two remittent cases.

The curves of the normal subjects A, B, C, and D require little or no discussion. They present the regularity which demonstrates the uniformity of the condition of the normal as contrasted with the variation and instability of the early dement.

Having compared the efficiency curves of the patients at the hospital with those of the normal subjects we now come to the study of the deterioration of the processes involved in this experiment or, in other words, to a consideration of the kind of errors made. Upon a careful inspection of the record sheets it was found that over 75 per cent of the errors made by the patients were of a sort that *might* be due to errors in transferring the first digit of the sum of one column of figures (if the sum had more than one digit) to add it to the sum of the next column to the left, the process commonly known as 'carrying.' But the results obtained from these records were not conclusive since it could not be proven from the sheets at hand that any of the errors were of this sort and further experimentation was required to demonstrate the increase in the number of errors in carrying in the early dement. The data necessary were obtained by again performing the experiment a great many times with the subjects used in the original tests. In this work no time record was kept and the subject was required to repeat aloud the numbers indicating the various steps in the addition as it was performed and these steps were recorded by the observer on a sheet similar to the one used by the subject, the two sheets being filed together. This made it possible to determine the source of each error made and in this way it was ascertained:

(1) That of the errors made in the addition a very large percentage were due to errors in carrying.

(2) That this percentage varied with different subjects, dependent apparently upon the degree of deterioration.

(3) That the percentage of errors of this sort in normal subjects was small, and, owing to the small total number of errors made, could hardly be determined, and

(4) That it varied in normal subjects, depending to some extent upon the proficiency of the subject in adding.

With some of the patients studied it was found that of the errors made a large percentage were errors in carrying, the highest being 93.8 per cent in case A. L. L. while with patients showing very little deterioration the per cent was very much lower, as, for instance, 33.3 per cent in case E. A. F. Thus we seem to find a direct relation between the degree of deterioration and the percent of errors in addition which are errors in carrying. The significance of this condition would seem to lie in the disturbance of the attention and particularly in the restriction of the attention field, the restriction of the scope of consciousness as deterioration progresses. Thus as the scope of consciousness is restricted the mind naturally grasps the concrete more readily than the abstract and, inasmuch as the figures of the next column are directly before the subject, they are concrete, while the digit to be carried from the column just added is abstract and consequently is lost from consciousness. That these figures to be carried remain in the borderland of the field of consciousness, that they are just beyond the limits of the scope of attention and are readily brought into the field, was demonstrated by case G. E. N., who presented a peculiar type of error in the process of carrying—a type of error very rarely found in normal subjects. This patient would fail to carry from one column to the next added, but instead would carry to the second and in a very few cases to the third column added. That this was done has been demonstrated a great many times with this patient, and such instances have been found with other patients, while one such error was observed with a normal subject, seeming to prove that the number to be carried remains outside the scope of consciousness at the moment when it should be added in, and is brought into consciousness later by some process whose workings and disturbances have not yet been analyzed. There is, it is true, a

similarity between the production of errors of this kind and the retardation found in some of the forms of dementia præcox, as when we ask a question and receive an answer some minutes later (cf. case H. E. M. answering the greeting after delay, see pages 12–13). In simple retardation we probably have a volitional disturbance which allows the setting free of a counter-impulse to retard, suppress or overcome each impulse received. Thus in the volitional disturbances so commonly seen we usually have retardation of all processes to a greater or less extent. In the case under consideration however we have one process going on undisturbed while another process intimately associated with it is in some way retarded or completely suppressed. This retardation is in the process which brings into the field of consciousness the abstract thing (the figure in the mind) which was for the time excluded, apparently by the concrete (the figures on the paper). But normally the number to be carried remains within the scope of consciousness and while the addition of the figures on the paper is a continuous process, the carrying must take place while it is going on. We cannot then say that the presentation of the abstract is simply retarded by the occupation of the attention with the concrete. We can only say, these errors are the result of a combination of disturbances of volition and mental elaboration by which the scope of consciousness is so restricted that the field is occupied chiefly by the more concrete imagery, while the process which should keep the other ideas within the field or bring them in when in some way they fall outside, is somehow retarded or suppressed.

The next two tests may be considered together since both are tests of the time of recognition and the same principles apply to both tests. In figure II the curves of the A-marking experiment, the numbers represent the average number of seconds required for perceiving and judging one A among four other letters. In figure III the curves of the card-sorting test, the numbers represent the average time of perceiving and judging the color of one card or one-fortieth of the discrimination time for forty cards.

In the curves of these two experiments we find the same general differences between the normal and the abnormal that

were found in the preceding experiment, since all are measures of judgment. We again find the irregularity, the deterioration and the improvement of the early dement contrasted with the uniformity of the normal subject. But we find some differences between these two and the preceding experiment and we must study each and compare the results. Beginning with the A-marking experiment we turn first to the curves of the normal subjects. We find that the curves of A, B and C, the three university students, lie very close together, are quite uniform and present a slight upward trend, denoting improvement with practice. The curve for D however begins much lower and though fairly uniform presents a marked ascent due to the influence of practice. Since this subject corresponds very closely in previous training and in social class and condition with the patients his curve may be regarded as the normal for that class and we may regard greater ascent in the curves of the patients as indicative of improvement and less ascent or descent as indicative of deterioration. Thus in curve H. E. M. we may trace the deterioration from the outset and note that at only one point does the curve reach the level from which it started. This point marks one of those brief periods often found in dementia præcox when the patient's condition seems to improve for a few days only to be followed by more rapid deterioration, as seen in the abrupt descent of the curve from this point and the termination a few weeks later indicating the point at which the patient was no longer able to carry out the experiment. In curve L. D. J. we find a paradox. As the deterioration progressed this patient (L. D. J.) became more and more automatic in his performance of some of the experiments. Thus with tests where time was the primary factor the curve ascends, seeming to denote improvement, while the ascent really marks the course of the deterioration as would be evident from a study of the number of errors made. In this case the number of errors made the first week was sixteen. The next week the patient took a great deal more time and made only eleven mistakes. This being before the period of rapid deterioration and the patient being in fairly good condition he was able to benefit by practice and, having become familiar with the routine of the

experiment, reduced the number of errors to seven in the third week. The work for this week represents probably the best of the entire series and from this point the number of errors begins to increase, the maximum being thirty-five or a little over one-third of the entire number of letters to be marked, while the time on this occasion was only 100 seconds, which is below the average for the normal subjects. It is evident that it would require much more than a proportional increase in time to increase the number of letters marked out to one hundred or, in other words, to reduce the number of errors to zero and the correction for accuracy made in the calculations for this set of curves is not sufficient. With the other subjects (normal and patient), however, the number of omissions was so nearly uniform that very little error was introduced and it did not seem advisable to sacrifice so clear a presentation of the results of the other subjects in this experiment in order to adapt it to this case. It was found that no uniform method of presentation could be used which would show both accuracy and speed without involving the pesentation of considerable amounts of useless data, since the other cases did not present this paradox. In curve O. O. L. of this test we find as in the preceding test the ascent marking the improvement in the patient's condition. Curve A. B. H. likewise presents a uniform ascent comparing favorably with those of the normal subjects. Thus the abrupt rise in the first few weeks marks the time when the effect of practice was greatest and the uniform rise from the third week may be regarded as partly the result of practice and partly the result of the improvement in the mental condition. Case E. A. F. again presents a uniform curve with slight ascent, probably due to practice, again furnishing evidence of the very slow deterioration in patients of this class. Cases A. L. L. and G. E. N. present the extremely irregular, abruptly ascending and descending curves to be expected from patients in the terminal stage of the disease. Case C. A. V., like case L. D. J., presented a paradox in that part of the curve marking the deterioration and, although the number of mistakes made increased as the work became more automatic, the increase in speed was enough to produce an ascent in that part of the curve.

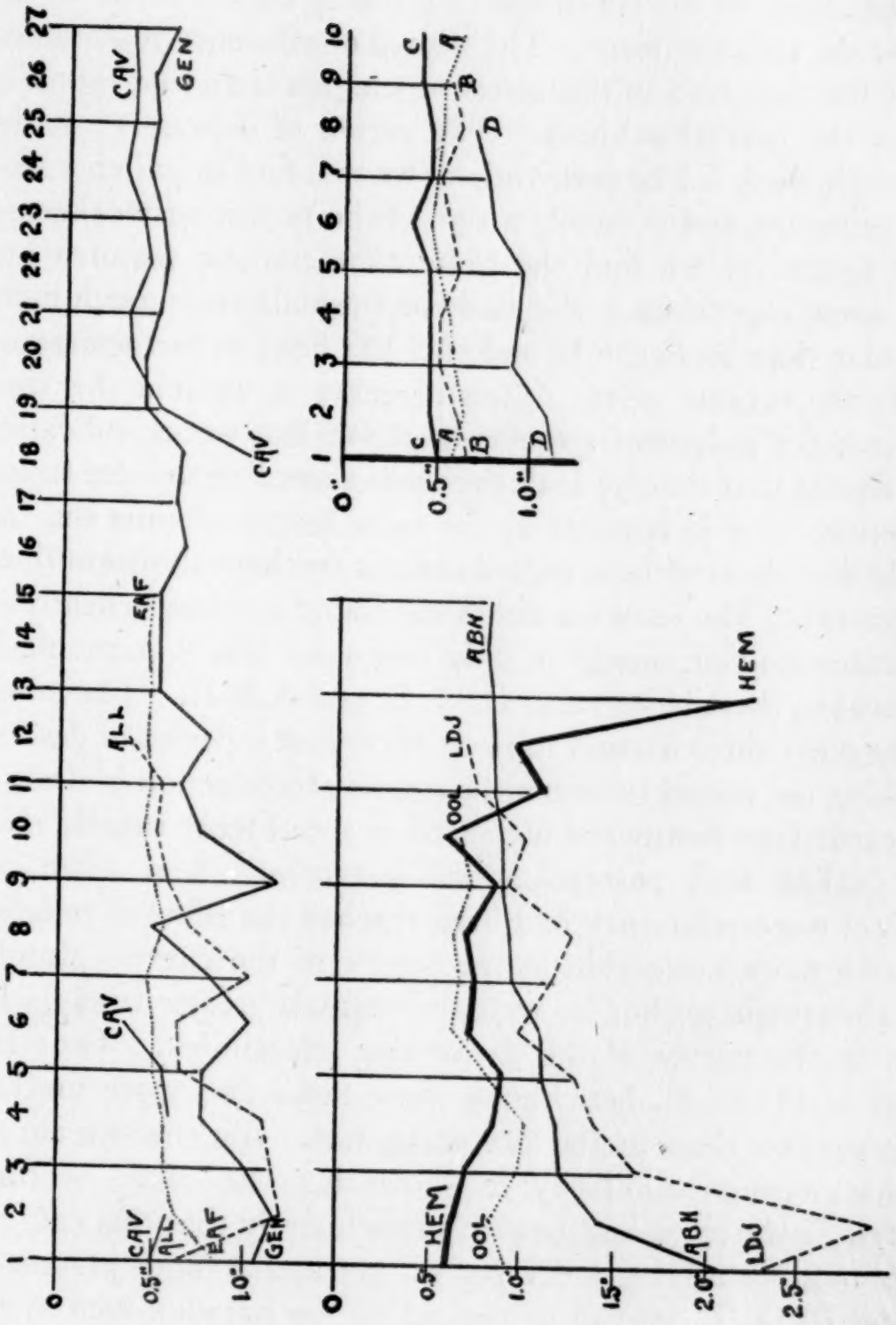

FIG. II. A MARKING TEST.

This automatism disappeared as the deterioration progressed further and did not reappear. Thus the second part of this curve represents the true value of the process measured and we see the ascent of the curve marking steady improvement to the end of the series of tests. The degree of efficiency maintained in the last four tests of this series was higher than that found in any of the normal subjects. The period of depression at the twentieth week is like many others we will find in patients who are recovering and is merely a sign of the persisting weakness.

In figure III we find the same characteristic features but with some exceptions. We find the normal curves much more irregular than in figure II and this has been in part accounted for in the various cases. Thus in curve A we find the time required for judgment remains as o for five weeks indicating that during that time he dealt the cards according to color (using perception and judgment) in the same length of time that he would deal them without regard to color (without the use of these processes). The same condition was found at times in nearly all the cases studied, though in only two cases was it particularly noticeable, these being cases O. O. L. and A. B. H. The curves of the other three normal subjects show first a period of descent marking the period in which the simple motor action of dealing the cards face downward increased in speed more rapidly than the dealing with perception and judgment. And when the limit of motor efficiency had been reached the effect of practice became more noticeable in the ascent of the curve. Among the abnormals we find as with the normals greater irregularity than in the curves of the A-marking experiment. Thus the curve of H. E. M. here shows more rapid and more marked deterioration than in the preceding test. But the two curves present enough similarity to show that the cause of their descent is the same and to prove conclusively that this cause is deterioration of the processes of perception and judgment. Curve L. D. J., instead of presenting the paradox seen in the preceding experiment, shows great irregularity with the general direction of the curve descending. The curves of cases O. O. L. and A. B. H., the two patients having remissions, show considerable irregularity but with the termination at a point show-

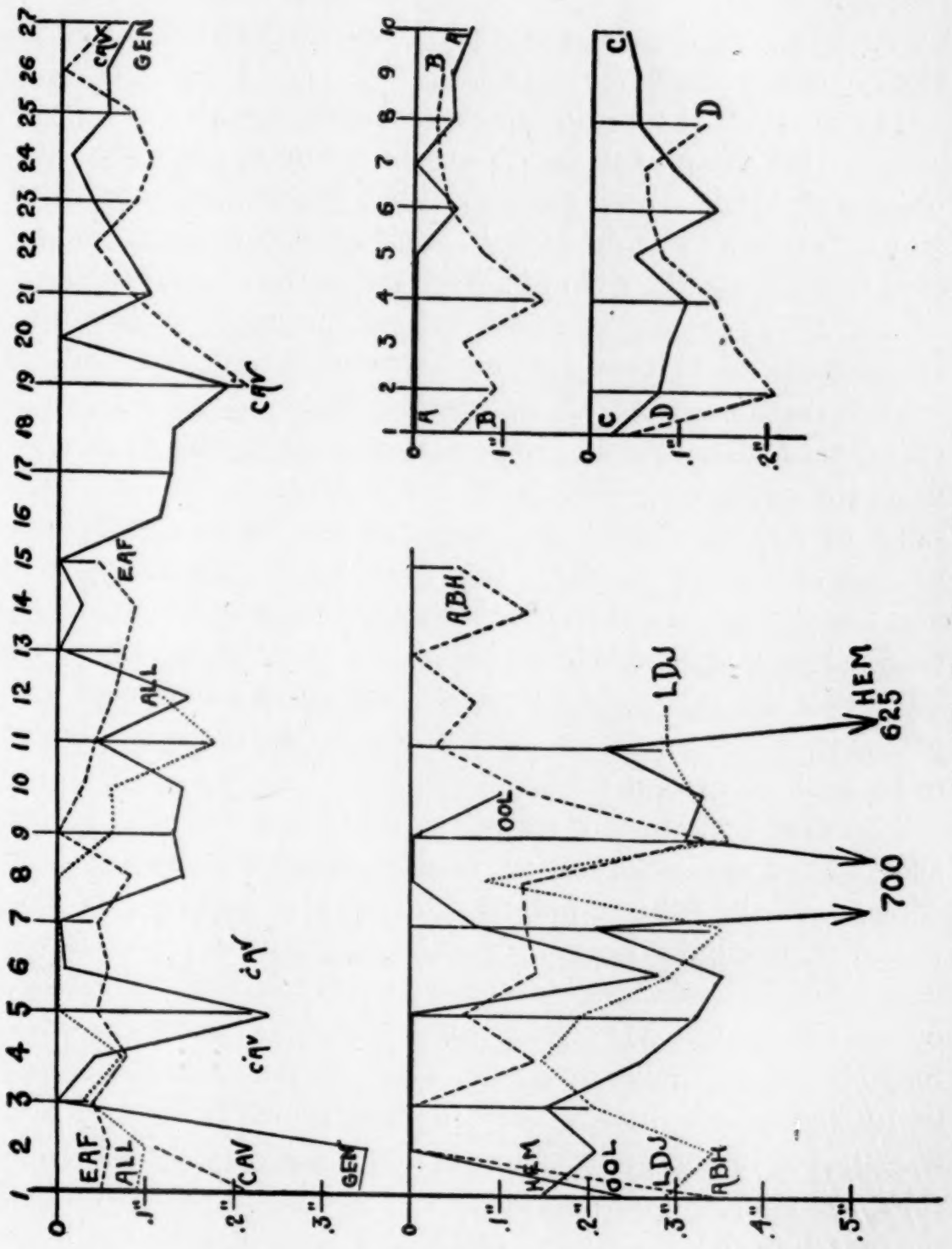

FIG. III. CARD SORTING TEST.

ing higher efficiency than at the beginning of the work. Curve E. A. F. is as usual the most regular presented by any of the patients. Curves A. L. L. and G. E. N. show the characteristic irregularity found in patients in the terminal stage, while curve C. A. V. shows the deterioration and later the improvement already demonstrated.

The question of most interest in connection with this experiment is that of an explanation for the o time of perception and judgment. It has been suggested that persons accustomed to playing cards a great deal would react quicker to the sight of a card face than to the sight of a back owing to the establishment of an acquired reflex through long practice. While this explanation might partially cover that of subject A it fails to explain that of case O. O. L. who had never played a game of cards, yet for six weeks of the ten covered by his series of tests dealt the cards with perception and judgment of color in the same or *less* time than that required for the simpler motor process of dealing the cards face downward. Both subject A and case O. O. L. fail to obtain any explanation by introspection. The most probable explanation is that the object or goal in sorting the cards according to color gives definiteness and precision to the act which is lacking when the cards are simply to be dealt in two piles.

The next experiments to be discussed are the tests of the accuracy of space perception as determined by the accuracy with which the subject judged the length of lines. The subjects compared the lengths of lines on cards, and they drew lines by comparison and by memory equal to a line seen. The curves for the last two tests (figures V and VI) show the error made in judging the lines used. Thus the processes measured, the method used, the basis of calculation and the scale of the curves used in the presentation of the results are the same for these two tests and they may well be considered together. For the first, however, a different method of presentation has been used (figure IV). In this experiment the subject was required to decide whether the various test lines used were longer, equal to or shorter than the standard line (100 mm.) and in this way the limits of accurate space perception were determined. In

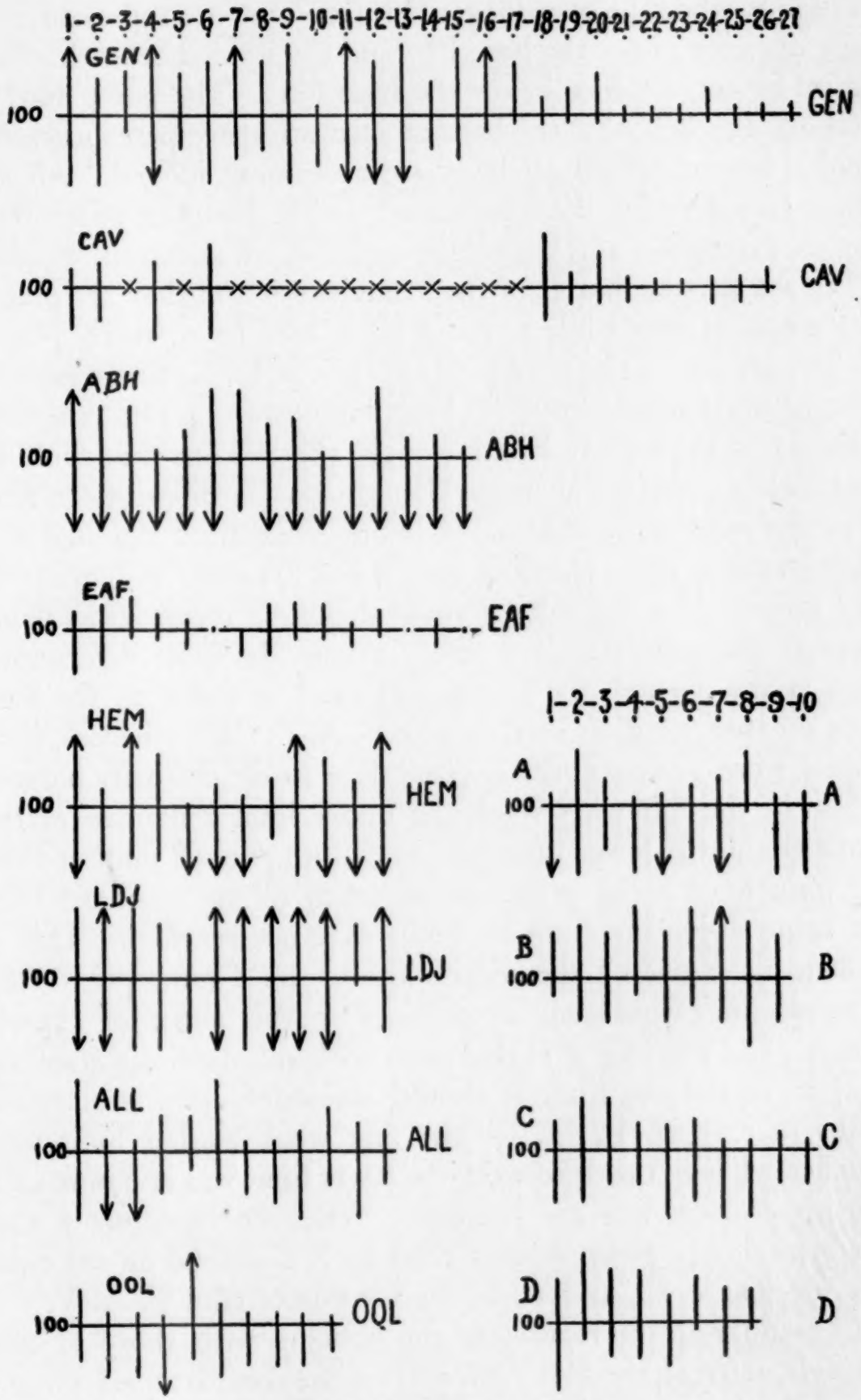

FIG. IV. COMPARISON OF LINES.

this figure the base line marked 100 mm. represents the standard line, while the lines longer than 100 mm. are represented by the distance above the base line and the lines shorter than 100 mm. by the distance below the base line. The point marked (above and below) is the limit of accurate space perception, the point beyond which all lines are accurately judged. All the lines falling within these points are within the limits of accurate space perception and the subject is therefore uncertain whether they are longer, shorter or the same length and they are placed by guess so that while some of them may be correctly placed others are not. Thus in figure IV, case O. O. L., first week, the record line extends from the base line upward 4 mm., showing that a line 104 mm. in length was the shortest line that could be accurately perceived as longer than the standard line of 100 mm. For the same week the record line extends from the base line downward 4 mm., showing that a line 96 mm. in length was the longest line the subject could definitely recognize as being shorter than the standard line. Where the limit determined was at the normal, the fact is indicated by a dot on the base line for that week, as seen in case E. A. F. the sixth week, both limits were at the normal, every line being correctly judged, while in the following week the upper limit remained at the normal and the lower limit was at 97 mm., the 98 mm. and the 99 mm. lines being perceived as equal to the standard line. In some cases the limit or limits were not reached. This is shown by extending the record line to the 8 mm. point (the greatest limit absolutely determined in this series of experiments), and marking it at this point with an arrowhead showing that to record the limit it should be indefinitely prolonged. Thus in case H. E. M. for the first week neither limit was reached while in the third week the lower limit was at 6 mm. and the upper limit was not reached. When no experiment was performed for a given week a cross or X is markd on the base line for that week, as seen in the records of case C. A. V.

In comparing the records of the patients with those of the normals, as usual, the striking feature is the comparative regularity of the latter as contrasted with the former. But in this experiment we find some exceptions to the rule. Thus in cases

E. A. F., C. A. V., and G. E. N., and, to some extent, in case O. O. L. we have records which parallel those of the normal subjects. This is easily explained. Case E. A. F. whose space perception is seen to be more accurate than that of the normal subjects had been employed for a number of years in factories of various sorts where by constant practice great accuracy of space perception had been developed and it must be remembered that this patient showed very little deterioration at this time. Moreover the processes of space perception are among the first developed and among the last to be lost. We would therefore expect to find deterioration manifested more slowly here than in the other processes tested. To what extent this is true cannot be definitely determined from this series of tests since the limits used in the experiments were not wide enough. In many cases the actual limit of accuracy in space perception was not determined (see the arrows on the records).

In case O. O. L. we have a patient who was improving rapidly and who did not show very much deterioration at any time during this attack. Thus it is to be supposed that the processes of space perception were but slightly affected and the two tests in which the limits were not reached (fourth and fifth weeks) resulted rather from lack of control of the attention than from any disturbance of the processes of space perception proper. A comparison of this curve with the curves of the same patient on other tests for the same weeks (4 and 5) shows that the patient was somewhat disturbed about this time and that his tests for the fourth, fifth and sixth weeks showed lower efficiency than at any other time covered by the ten weeks of this record. In case C. A. V. we have a record quite typical of the course of the disease. In this patient as in E. A. F. the processes of space perception had been developed to a greater degree than in the normals studied, as shown by the record of the last eight weeks of the series. The first few weeks were marked by rapid deterioration, and this is shown in the curve. Thus for the first two weeks the limit is the same and is much greater than the limit of the last few weeks, which may be supposed to be normal or at least approximately normal. For the third and fifth weeks there is no record as the experiment could not be

performed on account of the patient's lack of control of attention. In the fourth and sixth weeks the experiment was carried through and the increased limits give evidence of the deterioration. Thus in this case we have slow deterioration of the processes of space perception corresponding with very rapid deterioration of the other processes, no record during the crisis of the disease owing to the impossibility of holding the patient's attention long enough to perform the test, and finally, improvement during the first weeks of experimentation after the crisis and an apparently normal record during the last six weeks of the series.

In case G. E. N. we have a patient probably quite efficient in space perception but now in the terminal stage of the disease and showing considerable deterioration of the other processes, the disturbance of the attention being particularly noticeable. As a result it was impossible to keep the patient's attention on the test during the early part of the series and the limits shown from week to week vary greatly. About the seventeenth week, however, considerable improvement is to be noted and during the latter part of the series the work done was very good, the limits determined being less than those of normal subjects observed. This is to be explained by the fact that about this time some other work was begun with this patient, giving him considerable practice in judging the lengths of lines and perhaps training him to hold his attention on the work in hand better than in the early part of the series of tests. This curve thus shows that though the processes of space perception deteriorate with the deterioration of the other mental processes they may be restored almost to their normal efficiency by careful training even after deterioration has progressed so far that improvement in the more delicate mental processes has become exceedingly difficult if not impossible.

In the next two figures (V and VI) we have the curves presenting the results of the two other tests of space perception. As already mentioned the class of work and the method of presentation are the same in both experiments and as they were always performed together we may take them up and discuss them that way. Figure V presents the curves for the test in which a

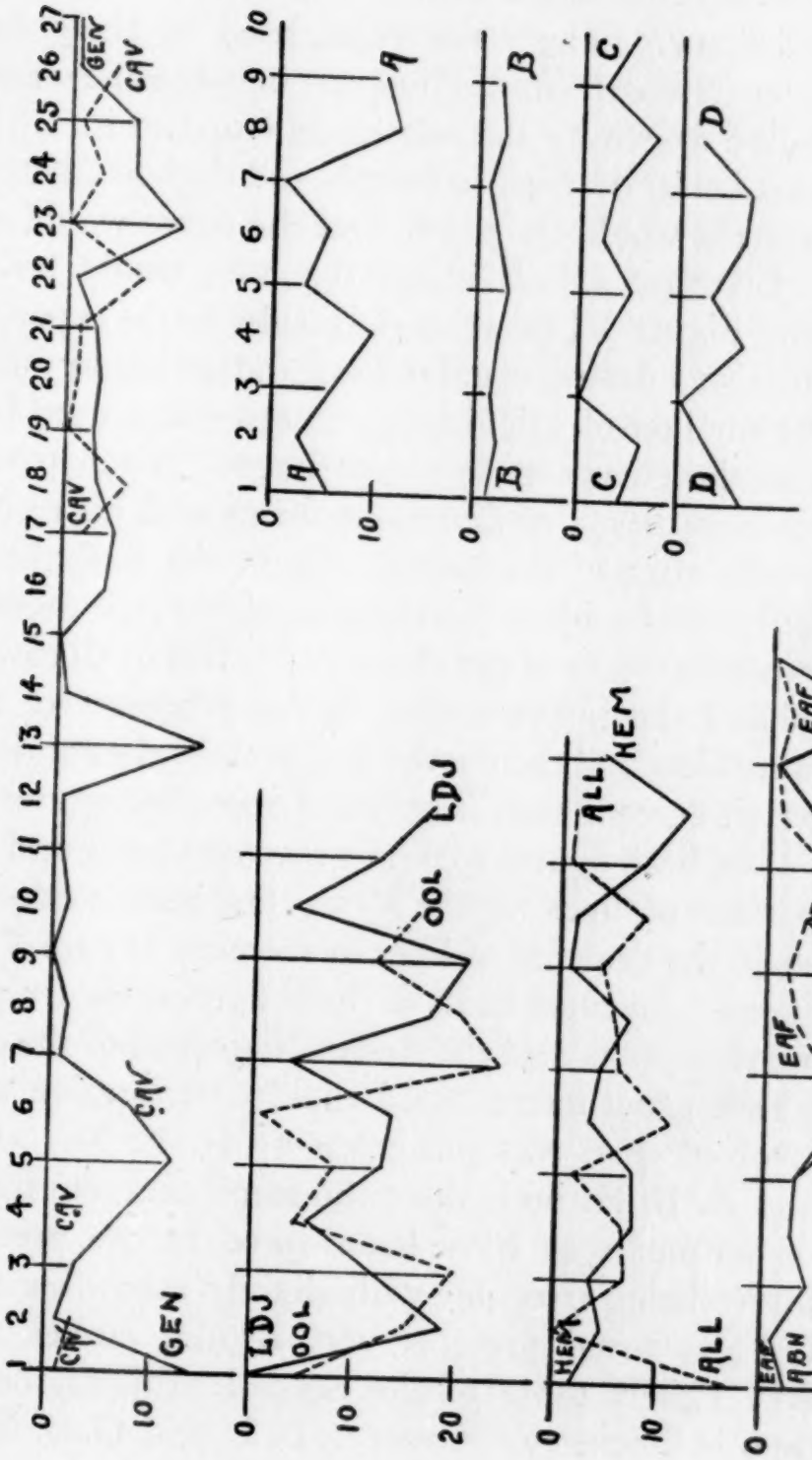

FIG. V. DRAWING LINES BY COMPARISON.

line was drawn equal to a standard line by comparison and the curve in each case marks the error in millimeters, the base line being above the curve so that ascent of the curve denotes fewer errors or increased efficiency and descent denotes more errors or decreased efficiency. The error value used in these curves is the difference in length (in millimeters) between the standard line and the line drawn by the subject as equal to it. Thus the line drawn being 97 mm. in length and the standard being 100 mm. the error would be 3 mm. and the curve would mark that point. Likewise a line drawn 104 mm. would have an error of 4 mm. Figure VI presents the results for the experiment in which a line was drawn equal to the standard line by memory and the same method of calculating the error was used in the preparation of the curves of this experiment. Each patient's record as shown in these two figures conforms with his record in the experiments already discussed. Again we find the uniformity of the normal subject and the irregularity, the deterioration and the improvement of the abnormal. But in all cases the deterioration and the improvement in the processes of space perception were slow and the curves do not show the continuous abrupt ascent or descent seen in some of the other figures. In curve H. E. M. of both figures we find great regularity and while in the comparison of lines (figure V) we find some evidence of deterioration, in the drawing of lines by memory (figure VI) we find little or none. In curve L. D. J. (both figures) the irregularity is more marked, as is also the descending trend of the curve, showing in both experiments more rapid deterioration of the processes involved than was presented by H. E. M. Cases O. O. L. and A. B. H. both show the same characteristics in these two experiments, as have been noted in the preceding tests, the curves being irregular with slightly ascending trend. Case E. A. F. as usual presents very regular curves which approach very closely those of the normal subjects, both in uniformity and in efficiency. Cases A. L. L. and G. E. N., the two patients who have reached the terminal stage, show as in the preceding experiments a great deal of irregularity with little or no evidence of further deterioration or improvement. Though we would naturally expect a lower degree of efficiency in these

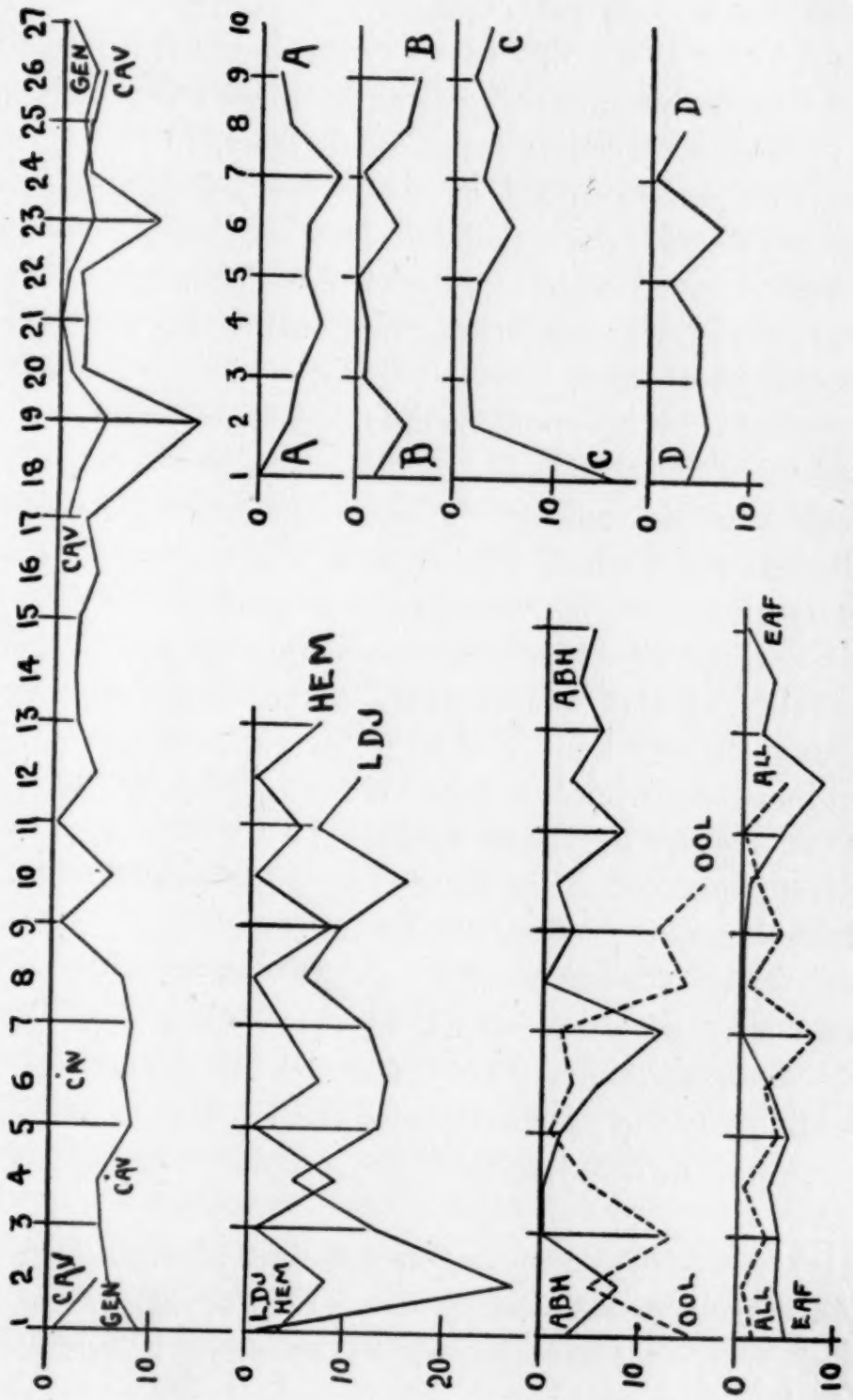

FIG. VI. DRAWING LINES BY MEMORY.

two patients, the explanation, like that in case E. A. F., lies probably in the nature of their previous occupation. It is characteristic that in the time covered by the work of these two patients there was no improvement. No other work was given which might act as training for this experiment and we may well contrast the work under these circumstances with that done by G. E. N. in the preceding experiment (figure IV), where special training was given during the latter part of the series. The conclusion to be drawn is that the deterioration has gone so far that the patient can no longer improve with the practice gained by repetition of the experiment at intervals of one week, while, if the interval be shorter, as in curve G. E. N., figure IV, some improvement may be noted. This conclusion is borne out by the conduct of patients in the terminal stages of dementia præcox, such patients making the same mistakes over and over and, though often corrected, seem unable to learn by experience or to improve with any ordinary amount of practice. It is possible that in the experiments any effect of practice may be counterbalanced and thus obscured by continual deterioration, slow though it may be. The effect of deterioration on ability to learn by practice has not been, in fact can not be determined to any satisfactory degree of accuracy.

The last experiments are the three tests of memory known as the 'letter-memory,' the 'picture-memory' and the 'word-memory' tests. Owing to the impossibility of reducing these results to a single curve which would show a complete and accurate determination of the efficiency of the processes involved in this group of experiments it seems best to present the results as in the original tables, compiled from the weekly reports.

The letter-memory test was performed by repeating a number of letters in an even tone of voice and at regular intervals and then requiring the patient to repeat the list as nearly as possible. A letter omitted was counted as one error, a letter not given but placed in the list by the subject, one error, while a letter changed from its position in the list was counted as one-half error. It will be remembered also that two lists of letters were used, the first list being repeated once, the second list twice, before the

subject was required to attempt to repeat it. The records of the two lists are placed together in the presentation of the results of this experiment (Table II). In this table the record of each subject occupies a double column, the case initials being placed at the top of the column, and the number of the week being noted at the right and the left of the table. In the column of any subject for a given week are four figures. The upper left figure represents the number of letters read aloud to the subject in the first list and the upper right figure the number of errors he made in repeating those letters. The lower left figure shows the number of letters in the second list and the lower right, the number of errors made in repeating the letters in that list. Thus it may be remembered that the figures on the left always represent the number of letters given and the figures on the right the number of errors made. Taking the record of case A. B. H. for the first week it will be seen that the first list consisted of five letters (read once) and that in this list no errors were made. For the second list he was given ten letters (read to him twice) and in this list he made three and a half errors, leaving out two letters, placing one in the list which was not used and transposing one letter from its normal position.

In the comparison of the results of this test with normal subjects and with patients we can readily see the lowered efficiency of the memory of the patient as compared with the efficiency of the normal memory. This is shown in two ways in the table, the first being in the smaller number of letters used in the early dement and the second being the greater number of errors made by this class of subjects. Owing to the variation, even of the normal memory, dependent upon the physical condition of the subject and the many other factors influencing mental efficiency, it has been impossible to establish or determine the exact relation between lists of different numbers of letters or to determine the variation in efficiency necessary to give a constant per cent of error with a variable number of letters. Of course doubling the number of letters more than doubles the difficulty of the operation, and this must be borne in mind in comparing the work of normal with abnormal subjects and of the same subject at different times. Thus the

Table II. The Letter-Memory Experiment.

	HEM	LDJ	OOL	ABH	EAF	ALL	CAV	GEN	A	B	C	D	
1	10 8½ 10 3	10 7½ 10 4½	7 1 10 4	5 0 10 3½	7 3 7 1	7 1 10 5	10 7 10 6½	10 × 10 ×	10 7 10 3	10 4½ 10 4	10 4½ 10 3	7 × 10 10	1
2	10 4 10 3½	5 2½ 10 6	7 1½ 7 5	7 1 7 1½	7 0 10 5	7 2½ 7 4	10 5 10 3	5 2 7 6½	10 5 10 3	10 1½ 10 4½	10 4 10 3	10 3 10 3½	2
3	10 6½ 10 0	10 5½ 10 7	7 1½ 7 1	7 2 7 1	8 5 8 6	7 2½ 7 2½		7 4 10 3	10 2 10 3	10 3½ 10 0	10 3 10 2½	7 2 10 3	3
4	10 4 10 1	7 2½ 7 2	7 2½ 7 4½	7 4 7 3	7 6½ 7 1½	6 2½ 7 1	7 4 7 1	7 3½ 10 13	10 5 10 2	10 0 10 0	10 3½ 10 2½	10 4 10 4	4
5	10 5½ 10 12½	7 2½	7 4½ 7 3	7 1½ 7 ½	7 2 7 2	7 2½ 7 2½		7 6 7 5½	10 4 10 4	10 4 10 0	10 2 10 1	10 3½ 10 3	5
6	10 2 10 4	7 1½ 7 0	7 1 7 3	7 1 7 4	6 ½ 7 ½	6 0 7 1	7 1½	7 6½ 7 1	10 2 10 0	10 2 10 2	10 2½ 10 1½	10 4 10 5	6
7	10 4½ 10 4	7 2	6 2 7 1½	6 1 7 2	7 1½ 7 1	7 3 7 2		7 4 7 4	10 4½ 10 5	10 2 10 0	10 5 10 4	10 3 10 3	7
8	10 3 10 3	6 0 7 4	7 ½ 7 3	7 4½ 7 3	7 4 7 3	7 1½ 7 1½		7 ½ 7 4½	10 7½ 10 2	10 0 10 0	10 3 10 5½	10 3 10 5	8
9	10 0 10 4½	5 2 5 ½	5 0 7 3	7 2 7 5	7 ½ 8 4	7 4 7 1		7 6 7 ×	10 1½ 10 3	10 2 10 0	10 1 10 5		9

10	10 1 10 2	7 7 5 0	7 1 7 2	7 1 7 5	7 1 7 0	7 2 7 1		7 4½ 7 3	10 3 10 2½		10 5 10 7		10
11	7 4 10 3	5 ½ 6 ½		7 4 7 2	7 ½ 7 ½	7 2 7 1½		5 0 7 2½					11
12	10 3½ 10 9	7 2 7 7		7 1½ 7 4½	7 1 7 ½	7 3 7 3½		5 2 5 0					12
13				7 3 7 2	7 3 7 1			7 × 5 1½					13
14				7 5 7 3	7 ½ 7 2			7 3 7 5					14
15				7 2 7 5	7 2 7 2½			7 4 7 7					15
16								5 0 7 2½					16
17								7 1½ 7 6					17
18							7 1 7 ½	6 1 7 5					18
19							7 1½ 7 3	7 2 7 2					19

Table II. The Letter-Memory Experiment—Continued.

	HEM	LDJ	OOL	ABH	EAF	ALL	CAV	GEN	A	B	C	D	
20							7 2½ 7 1½	5 0 7 5					20
21							7 1 7 2	5 ½ 6 6					21
22							6 0 7 1	5 0 7 3					22
23							7 2 7 2	7 4 7 6					23
24							7 1½ 7 1½	7 2 7 4½					24
25							7 2 7 2½	7 5 7 5½					25
26							7 1 7 0	7 9 7 7					26
27								7 6½ 7 6					27

normal subject D in the first week of his series was given seven letters which he repeated correctly but when a second list of ten letters was read to him twice he made ten errors in repeating the list or one-half the total number of errors possible. Many similar instances will be found throughout the table of results. Another striking feature of this experiment is that normal subjects as a rule remember the letters better, repeat the list with fewer errors, if it be read to them twice than if it be read but once. With patients however we will find that in a great many cases, in the majority of cases perhaps, the subject makes fewer errors in repeating the list of letters if he has heard it but once than if he has heard it twice. This interesting paradox is to be explained by the difference in the method used by the two classes of subjects in trying to remember the letters spoken. The normal subject as a rule has a certain method which he uses in each case and the repetition serves to fix the letters in mind better by intensifying the imagery, be it visual, auditory or verbal, and by strengthening the associations already formed and setting up new ones if the method of associations be used in memorizing the letters. Thus the subject is able to retain more of the letters used if the list is repeated twice than if only once and each additional repetition tends to decrease the liability to error. With the patients we find a different state of affairs. Here, as a result of deterioration, we find marked disturbance of attention and of the other processes concerned in memory. Association is always more or less affected as are the fundamental processes concerned in the different kinds of imagery. As a result the more complex associations such as those usually formed in attempting to memorize abstract, meaningless letters are the first to be disturbed. The disturbance of the processes of imagery likewise comes on early, making any method of learning the letters very difficult. As a result of the disturbance of the processes of attention the patient does not confine himself to any one method of learning the letters but goes from one method to another and while he may form visual images of the letters when they are first repeated he is quite likely to use some other form of imagery or association when he hears the same letters again. Thus, instead of reinforcement,

we are liable to find weakening and confusion due to the interference of the various methods with each other. This has been proven for normals by comparing the results in cases in which the subject used the same method throughout with the results where he was asked to use a number of different methods. Further evidence of the difference between the processes usually employed by normal subjects and those of the abnormals is to be found in the character of the mistakes made. With normals they are usually all of one class and are indicative of the method used, all letters substituted by the subject being, as a rule, in appearance, in sound, or in some other characteristic, similar to those for which each is substituted and showing that one method has been used throughout the list. With the patients we find errors of different sorts in the same list of letters, showing that two or more methods have been used on the same list. This is a typical example of the lack of thought control in dementia præcox and this disturbance of thought control plays a very important part in all of the disturbances of memory so characteristic of the early dement.

The other two experiments of this group are quite similar, (see the description of experiments), differing only in the character of the thing to be remembered and they may be considered together. The results of the 'word-memory test' are presented in Table III, and those for the 'picture-memory test' in Table IV. As in the preceding table, the weeks are numbered at the right and the left of the page and a subject's record throughout the series is read from top to bottom of the column indicated by the initials heretofore used to designate that subject. In each case record are four columns, the first being the time required to become familiar with the words or pictures on the cards used, the second being the time used in separating the original cards from the new ones, the third the number of cards used and the last the number of errors made. In studying this table it must be remembered that the number of errors includes both the number of original cards not picked and the number of new cards picked as original. The greatest number of errors possible would be made by failing to pick any of the original cards and at the same time picking all the new cards as

Table III. The Word-Memory Experiment.

	HEM	LDJ	OOL	ABH	EAF	ALL	CAV	GEN	A	B	C	D	
1	145 30 10 2	32 22 10 10	147 354 10 6	75 30 6 0	32 23 10 1	45 140 7 2	53 26 10 0	39 × 10×	54 18 10 0	21 26 10 0	19 20 10 2	30 24 10 0	1
2	75 25 10 1	20 29 10 6	86 140 3 0	56 52 7 1	30 23 10 0	18 22 7 0	26 42 10 5	23 × 10 0	17 22 10 0	11 19 10 0	23 20 10 1	50 55 12 3	2
3	20 15 10 2	27 × 10 8	46 398 7 0	43 58 7 1	27 25 10 3	20 14 7 1		35 × 10 0	17 30 10 1	16 18 10 4	19 17 10 2	35 28 10 1	3
4	43 22 10 0	20 26 10 7	22 236 5 1	72 56 7 3	9 16 7 1	21 27 7 0	29 35 10 5	45 × 10 1	20 23 10 0	13 16 10 2	15 16 10 2	36 30 10 0	4
5	130 65 10 2	12 35 5 4	40 140 5 0	48 55 7 0	9 16 7 1	8 22 7 4		× × 10 3	19 26 10 0	12 19 10 2	21 16 10 1	20 30 10 0	5
6	125 46 10 1	15 × 5 6	20 93 5 0	63 89 7 0	9 17 7 2	9 23 7 3	20 80 7 3	× × 10 1	20 22 10 0	18 19 10 1	22 17 10 1	23 34 10 2	6
7	100 58 10 0	10 40 7 8	28 118 5 0	90 60 7 1	9 17 7 2	11 15 7 0		× × 10 7	15 20 10 1	15 18 10 0	28 22 10 1	16 30 10 2	7
8	× × 10 1	7 115 7 8	35 × 5 0	80 63 7 0	7 20 7 0	15 12 7 1		45 × 10 1	12 19 10 0	14 20 10 0	21 16 10 4	16 50 10 4	8
9	75 28 10 0	9 11 5 5	30 147 5 1	65 55 7 0	9 57 7 3	10 17 7 1		70 165 10 0	13 19 10 1	16 18 10 0	22 25 10 1		9
10	20 80 10 2	9 60 5 2	15 131 5 1	83 107 7 2	8 49 7 4	5 10 7 2		40 × 5 4	14 20 10 0		19 16 10 4		10
11	25 40 10 2	23 50 5 4		103 65 7 0	11 22 7 2	7 13 7 1		20 142 5 ½					11
12	15 105 10 5	16 43 7 8		115 100 7 3	13 16 7 0	6 30 7 3		30 300 5 4					12
13				100 80 7 0	10 40 7 2			40 220 5 2					13
14				100 100 7 0	14 27 7 1			33 46 5 0					14
15				57 82 7 0	9 15 7 1			27 60 7 3					15
16								18 × 5 0					16
17								32 × 5 0					17
18							27 15 7 0	13 15 7 0					18
19							25 19 7 ½	40 × 7 0					19
20							22 48 7 2	24 × 5×					20
21							20 × 7 ½	27 × 7 3					21
22							26 16 7 0	96 300 7 0					22
23							16 35 7 0	67 230 5 1					23
24							14 20 7 ½	34 100 5 0					24
25							16 33 7 2	30 70 5 4					25
26							18 33 10 3	38 × 5 ½					26
27								40 210 5 0					27

Table IV. The Picture-Memory Experiment.

	HEM	LDJ	OOL	ABH	EAF	ALL	CAV	GEN	A	B	C	D	
1	65 57 10 1	32 23 10 4	212 126 10 2	42 41 10 0	25 16 10 0	32 30 7 0	42 22 10 0	63 91 1010	27 16 10 1	12 14 10 0	44 19 10 1	45 40 10 0	1
2	57 30 10 0	57 45 10 12	49 38 5 0	37 41 7 1	22 × 10 1	20 34 7 5	17 27 10 1	35 98 10 2	17 16 10 0	8 13 10 1	33 20 10 1	33 72 10 0	2
3	48 35 10 1	22 × 10 9	50 100 7 0	32 24 7 0	20 20 10 0	15 23 7 2		× × 1010	30 25 10 1	14 25 10 1	20 22 10 1	32 50 10 0	3
4	50 35 10 1	× × 5 2	30 87 7 3	36 85 7 2	16 12 7 1	19 43 8 2	38 32 10 0	25 × 10 2	18 28 10 0	11 19 10 0	16 18 10 2	50 38 10 0	4
5	45 × 10 5	72 × 5 0	100 190 5 0	60 23 7 0	10 18 7 0	14 16 7 1			20 23 10 0	12 23 10 1	14 23 10 0	30 45 10 0	5
6	× × 10 1	7 50 5 4	80 90 7 0	53 63 7 2	12 20 8 0	10 22 7 6	× ×5 0	× × 10 2	20 × 10 1	12 17 10 2	28 25 10 2	30 31 10 0	6
7	47 55 10 1	7 × 7 7	50 24 8 0	65 50 7 0	16 15 7 0	14 23 9 0		× × 10 0	17 29 10 0	15 22 10 1	35 22 10 0	57 35 10 0	7
8	120 50 10 0	10 54 7 8	55 55 7 0	38 33 7 0	9 18 7 ½	18 19 7 1		35 × 10 0	15 22 10 2	15 22 10 2	29 20 10 0	40 21 10 0	8
9	45 46 10 0	12 9 5 5	48 95 7 0	27 60 7 0	15 31 9 0	7 12 7 1		60 × 10 0	15 18 10 0	15 17 10 2	29 18 10 2		9
10	48 89 10 2	8 50 5 4	38 58 7 0	68 140 9 2	12 19 7 0	19 16 7 5		30 50 3 0	17 18 10 0		24 17 10 1		10
11	53 37 10 0	12 48 5 6		62 52 7 0	12 17 7 0	6 15 7 3		70 75 5 0					11
12	15 46 10 1	15 67 5 6		53 45 7 0	12 17 7 1	12 16 7 2							12
13				60 40 7 0	8 10 7 0			57 × 5 0					13
14					17 25 10 1			26 19 7 0					14
15				55 30 7 0	10 12 7 0			38 × 7 1					15
16								20 × 5 2					16
17								30 20 5 0					17
18							15 16 7 0	35 27 7 0					18
19							16 14 7 0	47 × 7 2					19
20							30 18 7 0	22 22 7 8					20
21							23 × 7 0	28 72 7 1					21
22							23 16 8 0	35 600 5 1					22
23							12 14 7 0	43 55 5 0					23
24							17 17 7 0	23 30 5 0					24
25							18 22 9 0	20 60 5 1					25
26							18 17 10 0	33 117 5 0					26
27								40 × 5 0					27

original and would thus be equal to twice the number of original cards used. This explains why the number of errors (last column) is in some cases larger than the number of cards used for the test (third column).

In comparing the abnormal with the normal records on these two experiments we find the same points of difference that have already been noted in the preceding experiment. We find the number of cards used with the patients much smaller than with the normal subjects, and, as has been stated, it is impossible to determine the relation of one number of cards to another as regards the degree of efficiency necessary to perform the test without error. But in order to make a comparison of time and errors in the two classes of subjects it was necessary that the test be no more difficult for a patient than for a normal and therefore that the number of cards used with the patients be less than the standard number used with normals. In this way the number of cards used shows something of the great difference in efficiency between the normal and the dementia præcox patient. The next point to be noted is the number and the sorts of errors made by the two classes of subjects. A study of the table will show that the percentage of errors for the patients was much higher than for the normal subjects in spite of the fact that the test was made much easier for the former. Under the same conditions the normal subjects would show a much smaller percentage of error than they do. The character of the errors made as in the preceding test shows evidence of the characteristic disturbances of the memory processes.

The same disturbances are found as in the preceding experiment but they are evident in less degree as the work in this test is not so difficult and does not call into play some of the finer processes whose disturbances become more evident as the work becomes more difficult. The difference between the tests lies primarily in the difference in the thing to be remembered. In the preceding experiment it was a letter, an abstract thing, difficult to associate or to image. In the 'word-memory' and the 'picture-memory' tests we have something relatively concrete. The word or picture used is a symbol and involves more imagery than the letter. It is readily associated with

something else to fix it in memory and lends itself readily to imagery of one sort or another. Moreover in these tests the subject is only required to decide when he sees a card whether or not it is one that he has seen before (during the test) while in the 'letter-memory' test there is no suggestion of the letter to be remembered. The subject must bring it out. The greater difficulty of reproducing is readily seen in normal persons who cannot recall a given name or word but who recognize it immediately when it is spoken. Thus these two experiments do not require such perfect imagery nor such a high degree of attention as the preceding one and do not show so markedly some of the disturbances evidenced in that experiment. The only other feature demanding attention is the time required for learning the cards given and for separating the new ones from among the original cards. In each case the subject was told to use only what time was necessary, and he knew that the time occupied was made a part of the record of the experiment. Under such conditions the difference in time between patients and normals is indeed significant. It will be found that the average time per card required by the patients is many times that of the normals, for, from the tables it is to be seen that the patients in many cases required more time for a smaller number of cards than was used by the normal subjects. This is significant of the disturbance of the attention which comes into play in this experiment, lengthening the time till, in some cases, it was found impossible to tell even approximately what amount of time was used. The particular form of disturbance exhibited was rambling thought or distractibility of the attention, the suggestion given by the picture or word on the card before the subject carrying him far afield. Thus a patient may sit for some time gazing fixedly at a card while instead of having his attention fixed on that card he is following a chain of rambling, dissociated ideas, connected perhaps by only a single word in each sentence or thought. Thus the end reached is likely to be an idea in no way connected with the one on the card and one which will tend to confuse the patient rather than to help him to fix the word or picture in memory. The long time required is significant and quite characteristic of dementia præcox.

When we consider the facts presented in the tables: when we see that the patient falls far below the normal in each of the factors here considered; i. e., in speed, in accuracy, and in the amount of the work done at a given time; we can, by correlating all these factors, obtain an approximate estimate of the efficiency of the memory processes in the two classes of subjects studied. It is only when we correlate these factors, forming an estimate of efficiency, that we can realize the extent of the disturbance of the memory processes in dementia præcox.

The next experiment is a simple measure of motor efficiency as determined by the rapidity of tapping on paper with a pencil. This record is presented in figure VII, in which the curves mark for the various weeks the actual number of dots or taps made in thirty seconds. An ascending curve means increase in speed and presumably higher efficiency though in one or two cases paradoxes are found which must be described and explained. Thus case L. D. J. shows in this experiment the same paradox noted in some of the preceding experiments. As the deterioration progressed the work became more automatic, seeming to show increased speed and increased efficiency which is really a decrease in motor efficiency, inasmuch as the work is automatic and not the result of voluntary control. The other curves show the same characteristics as in the preceding tests. Thus H. E. M. presents an irregular curve with descending trend but with some ascent, probably paradoxical as with L. D. J., just before the end of the curve at which time work became impossible due to the extreme deterioration. Cases O. O. L. and A. B. H. as in the preceding experiments present curves characteristic of the course of the disease and case E. A. F. presents an ascending curve showing much improvement with practice and furnishing evidence that the very slow deterioration in this case has not yet affected such simple motor processes. Curves A. L. L. and G. E. N. show nothing unexpected except the ascent in the latter part of curve G. E. N., and this has not yet been satisfactorily explained. In point of time it corresponds to the improvement in the judging of lines on cards and though there was some improvement about this time following a period of depression and accompanied by some improvement in physical

condition it was hardly sufficient to account for such a marked improvement as is shown in these two experiments. It is probable that as work with some of the other patients was discontinued about this time and special work with this patient taken up as noted before, there was some improvement in motor efficiency due to the training (special work) used from this time and this may account for a part of the improvement. It must be remembered that the efficiency of this subject had been very low and that while the comparative increase was great the degree of efficiency as a result of this improvement was still low. The record for case C. A. V. is typical of the course of the disease, the direction of the curve for the first few weeks being steadily downward shows the decrease in motor efficiency with very rapid deterioration. The curve is broken for the weeks in which no work was done and, beginning again, ascends rapidly with the final improvement reaching a high degree of efficiency which is maintained during the last few weeks of the series. The curves of the normal subjects show no striking characteristics, presenting simply the uniformity and slight improvement with practice that we would be led to expect from the character of the work done on the other experiments.

The last to be discussed is the association test which has come into some prominence in the past few years. Its chief value in this work, as in much of the work that has been done with it by other investigators, has been in determining the habitual content of a subject's thought by discovering the ideas or lines of thought in which the subject presents the greatest facility of association. With normal subjects the associations have no particular significance. We find that in any line of thought, familiar to the subject, association is quick, accurate and easy, showing the normal command of his store of ideas. The answer words given (see the description of the experiment) were always logical associations with the original word, and the time was always short, varying from a fraction of a second to three or four seconds. Where words were used with which the subject was entirely unfamiliar no association word was given.

In the work done with this test on dementia præcox patients we find a number of results of particular significance. First,

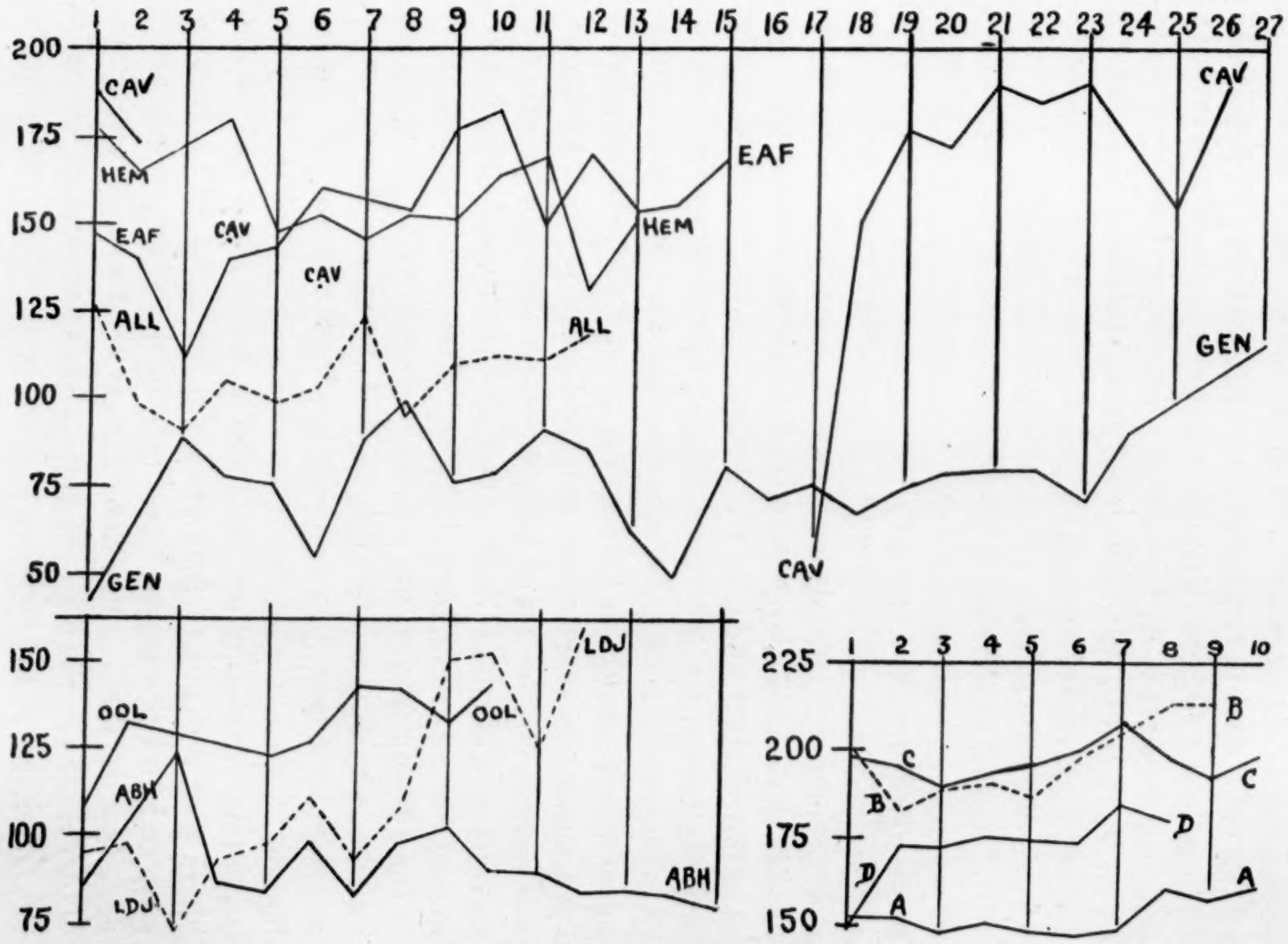

FIG. VII. MOTOR EFFICIENCY TEST.

and most important, are the indications of the content of thought, especially since they confirm the evidence from other sources. This test was used but little with case H. E. M. yet the few associations that were obtained showed the marked disturbance of the emotional processes and the predomiance of the sexual feelings in the content of thought. The same was true but to a less extent of cases A. L. L. and G. E. N. and at one time of C. A. V. Case E. A. F. presented as the chief content of thought his delusions regarding the German empire of which he believed he was to be the ruler. The associations in cases O. O. L. and A. B. H. and in the last few weeks of C. A. V. did not present any marked persistent idea nor did any single line of thought seem to occupy the mind to the exclusion of others. These patients showed apparently the same facilitity of association as the normals of the social class to which they belong. The weakness of the associative powers is shown however in these cases, as in the others studied, by a lengthening in the time required for a single association, or by the offering of answers which are not true associations with the test words used. At times associations which seemed to be illogical proved to be logical, but in such cases the answer was usually found to be, not the first association, but the last of a chain of several words or ideas, each associated with the following one and the preceding one as in flight of ideas or rambling thought. To obtain clinical records of such flights of ideas the subjects were given a single word and told to write in a column the words forming the chain of ideas following that word, the process being continuous for a given length of time. This time varied for the different subjects, according to the rapidity with which they formed associations. In this way many typical examples of flight of ideas were recorded and the lists showed plainly the effect of loss of the goal idea in the erratic and illogical tendency of association which results in the flight of ideas and the rambling thought so characteristic of the writings and conversation of the dementia præcox patient.

PSYCHOLOGY OF DEMENTIA PRÆCOX

What then are the mental marks of dementia præcox as shown by these experiments? We have seen the lengthening in time and the errors in carrying in the addition test, the missing of the A's in the second experiment, the misplacing of the cards in sorting, the inaccuracies of space perception, the disturbances of memory and association and the decrease in motor efficiency. On what do they depend?

To answer this question we must make a careful analysis of the causes underlying the errors and the retardation shown in the experiments and such an analysis will show that while there are several factors which vary in the different experiments according to the set of mental processes being tested, there is one which remains constant. It is the *loss of thought control.* Let us turn for a moment to the experiments and note its effect. That such a disturbance will have a marked effect on the time required for the various processes is evident for we can readily see that if a subject has not the normal control of thought and allows himself to wander mentally from the work in hand and then to return to it, the time during which his mind was not occupied with the work of the experiment is time lost. It is also probable that after the attention has strayed from the work it may return and repeat a part which had already been done, and of course the time required for this repetition would constitute a loss of time in addition to that during which the mind was not occupied with the work. That such a repetition may readily occur has been proven many times in the actions of the various patients on the wards and a good example of it is to be seen in the repeated greeting of H. E. M. as cited in the case history of that patient. Thus the increase in the time used in the various tests is a direct result of the loss of thought control, and the possible extent of its effect is nowhere better shown than in the lengthening in time in case H. E. M. (see Table I, case history). It will be remembered that in this case the loss of thought control was such that the subject would pause in the middle of an experiment to converse with his 'voices' and would then return to the work in hand. Toward the end of the

series of tests with this subject the time on some of the experiments was lengthened to several times that in the first tests of the series. It was on account of the progressive decrease in thought control, lengthening the time used to a point where it could no longer be determined to a satisfactory degree of accuracy that the experimental work with this patient was eventually discontinued.

The effect of loss of thought control upon the character of the errors made in the different tests is even more significant. Thus in the addition test we find the errors in carrying growing directly out of the loss of thought control which allows the digit which is to be carried to escape from the field of consciousness by allowing the boundaries of that field of consciousness or thought to shift so that they no longer include that digit. These boundaries may again shift to include this digit and so give rise to the delayed carrying so often seen in G. E. N. In the A-marking experiment the error resulting from loss of thought control is the missing of the A's which are mixed among the other letters. Thus the subject may be marking out the A's in this list, his pencil point moving along the lines of letters designating the point up to which he has or supposes he has marked out all of the A's. If then, due to loss of thought control, his attention leaves the sheet of letters for a moment, the movement of the hand with the pencil point will continue automatically. When the subject's attention returns to the sheet it is to the place then designated by the pencil point, and one or more A's may be missed, having been passed by the moving point, during the time in which the attention was not upon the work. That this is the way in which the A's are omitted has been demonstrated introspectively and also by having subjects, both normal and abnormal, perform this test repeating the letters aloud. It may also be shown that the errors arise in this way by having the subject read aloud a long list of single digit numbers and add them instead of marking out some of them. The omission of numbers is shown by their not being read aloud and their not being included in the final sum. The principle of the omission is the same. In the card-sorting experiment the loss of thought control acts just as in the A-marking and the errors

probably arise in the same way, the only difference being that instead of moving a pencil point along a line the subconscious act in this experiment is the dealing of the playing cards and when this goes on without attention the cards may or may not be properly placed. Thus the appearance of an error in the sorting of the cards from a lapse of attention in this experiment is not so certain to occur as one in the marking of the A's. The mechanism of the errors made, however, is the same.

In the tests of space perception a different set of processes comes into play but the attention is still of primary importance and in so far as it is affected space perception will be inaccurate. In the judging of lines on cards for example, due to momentary loss of attention to the work, one of the cards bearing a line 6 mm. longer than the standard may be picked as the same length as the standard line and though the upper limit of accurate space perception with the best attention of which the subject is capable may be 102 mm. and the lines between this and the one misplaced (that is 103, 104 and 105 mm.) may be properly placed. But the error due to the loss of thought control places the limit of accurate space perception as shown by this experiment at 108 mm. (the shortest line accurately judged as longer than the standard line).

The importance of attention to association and memory is too well known to require any discussion here, and such a disturbance of the thought control as has been shown in the preceding tests would naturally affect the accuracy of the work on the memory tests. The extent of this effect is readily seen in the error columns of the tables presenting the results of the three memory experiments. In the association tests the same underlying factor is again demonstrated in the illogical associate words given by the patient where only the first association was required; and the rambling train of thought shown in the associations when the patient was asked to write a list of associated words starting from a given word, is the homologue of the rambling thought in the patient's conversation which has been descibed as due to loss of the goal idea, and which is none other than the loss of thought control as we have demonstrated it in the preceding experiments. This is one of the typical features

of dementia præcox conversation. It is found alike in C. A. V.'s ravings in the strong room and in G. E. N.'s descriptions of his boyhood excursions or of his experiences in the various wards of the hospital, and it is the same loss of thought control which prevents A. L. L. from giving a good narrative description of his life in America before his commitment to this hospital, while he can answer almost any question regarding the events of that period.

Many of the emotional disturbances described in the case histories of these patients grow out of and in part cause this disturbance of the attention. Interest and attention are one, and in the loss of thought control, the disturbed attention, as shown in the experiments, we have an idea of the patient's loss of interest in his surroundings and his consequent failure to adjust himself to them. It is because attention is not normal that L. D. J and A. L. L. sit for hours without taking any interest in the happenings on the ward or the actions and conversation of the patients about them, and it is from the same cause that G. E. N. when transferred from one ward to another tries to go to the dining-room by the same route as before and calls the attendants by the names of those on the wards from which he has come.

It is the loss of this control, that forms the basis for many of the volitional symptoms, making the patient negative in some cases and inefficient in others. He may be unclouded and be able to make good sensory judgments but this loss of the 'drive' or control of his mental processes makes him unable to evolve and follow out a rational procedure on the basis of these judgments and makes any complex judgment impossible. Thus when L. D. J. or H. E. M. is told to do a certain thing his sensory judgment is complete and correct but he lacks the control to enable him to execute the order. Instead, the control being disturbed, he does the opposite, or does nothing at all, and the result is known as negativism. He does not fail to do the thing directed on account of a complex judgment which shows him that the thing directed would be injurious to him. His judgment is correct but he has not the control necessary to enable him to act in accordance with that judgment.

Thus in conclusion we may say that of all the disturbances of which we find evidence in these experiments the most fundamental is the loss of thought control, since this control is the very fiber of the mind. The impairment and loss of this control of thought is the most important part of the progressive mental deterioration so characteristic of dementia præcox.